Marine Fish and Invertebrate Atlas: Summarizing Geographic Distribution and Population Indices in the Scotian Shelf and Bay of Fundy (1970-2020)

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MARINE FISH AND INVERTEBRATE ATLAS: SUMMARIZING GEOGRAPHIC DISTRIBUTION,
POPULATION INDICES AND ENVIRONMENTAL PREFERENCES IN THE SCOTIAN SHELF
AND BAY OF FUNDY (1970-2020)

by

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ABSTRACT

Ricard, D. and Gomez, C. 2021. Marine Fish and Invertebrate Atlas: Summarizing Geographic Distribution, Population Indices and Environmental Preferences in the Scotian Shelf and Bay of Fundy (1970-2020). Can. Tech. Rep. Fish. Aquat. Sci. nnn: viii + 81 p.

The summer groundfish research vessel survey on the Scotian Shelf and in the Bay of Fundy started in 1970 and was designed to measure the distribution and abundance of major commercial fish species. Over time, additional information on non-commercial species was collected, and allowed considerable insight into ecosystem function and structure, as documented in many primary publications whose analyses used the survey data. The same groundfish survey database has also been used to produce species status reports, atlases of species distribution and remains an essential source of information for stock assessments in the Maritimes Region of Fisheries and Oceans Canada. This report builds on previous work and former atlases by updating a comprehensive suite of indices to assess population status and environmental preferences of 104 species. For each species, trends in geographic distribution and biomass or abundance were plotted. The spatial extent of distribution was plotted over time to gauge how the area occupied has changed. The relationship between abundance or biomass and spatial extent reflected whether the species distribution expands when abundance or biomass increases. Length frequencies over time depicted any changes in mean size. The plots of condition over time revealed whether individual fish are fatter or thinner than their long term mean. Depth, temperature and salinity preferences were estimated to gauge the range of suitable environmental parameters for each species. Finally, for each stratum, the slope describing how local density varies with regional abundance was estimated.

RÉSUMÉ

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1 Introduction

The summer (July-August) groundfish research vessel survey on the Scotian Shelf and in the Bay of Fundy was started in 1970 by Fisheries and Oceans Canada Maritimes Region. The survey was originally designed to measure the distribution and abundance of major commercial fish species. Over time, information on non-commercial species was also collected. The groundfish survey database storing the information collected during the annual survey provides the main source of fisheries-independent information for marine species in the region. This information is routinely used to support stock assessments, to produce species status reports and has been previously used to publish atlases of species distribution.

The current document is an update of an earlier report (Ricard and Shackell 2013) that built on former atlases by updating a comprehensive suite of derived indices for 104 species to assess population status and environmental preferences. The information collected during the survey is stored in a relational database management system archived at Fisheries and Oceans Canada Maritimes Region which contains detailed information about the sampling locations and the associated catch. Tow-level survey data is also publicly available from the Ocean Biogeographic Information System (DFO 2016) and (FGP link TBA). The present atlas follows on the work done by Fisheries and Oceans colleagues from the northern Gulf of St. Lawrence (Bourdages and Ouellet 2012), southern Gulf of St. Lawrence (Benoît et al. 2003) and on earlier work in the Scotian Shelf (Simon and Comeau 1994; Horsman and Shackell 2009).

To facilitate updates and foster collaboration on the analyses of the survey data, the computer code necessary to extract the data, to perform the analyses presented herein, and to reproduce and update the current document is made available in a git repository (Ricard and Gomez 2021).

The survey area covers three major Northwest Atlantic Fisheries Organization (NAFO) zones that divide the shelf into the colder east 4V and 4W (strata 440-466) and warmer west 4X (strata 470-495). Temporal trends are plotted by NAFO regions for several species. For each species, trends in geographic distribution and biomass or abundance are plotted. Some caution is required in interpreting the results obtained for several taxa due to low sample size as explained later in the text. The spatial extent of distribution is plotted over time to gauge how the area occupied has changed. The relationship between biomass and spatial extent reflects whether the species distribution expands when biomass increases. For each strata, the slope describing how local density varies with regional abundance was estimated (Myers and Stokes 1989). These slopes were then plotted against a habitat suitability index to identify important strata for each species. Then, length frequencies over time depicted any changes in mean size. The plots of condition over time revealed whether individual fish are fatter or thinner than their long term mean. Finally, depth, temperature and salinity preferences were estimated to gauge the range of environmental parameters (Perry and Smith 1994). A full ecological interpretation of trends is beyond the scope of this report. Other documents stemming from peer-reviewed scientific processes under the auspices of the Canadian Science Advisory Secretariat (CSAS) provide further descriptions of spatio-temporal trends in different indicators and put the information collected during the summer groundfish research vessel survey in a more focused context (see for example Clark and Emberley (2011)).

2 Methods

2.1 Survey Description

The survey is conducted annually in July-August and covers the Scotian Shelf and the Bay of Fundy (Figure 1). It normally involves two separate two-week trips on board an offshore fisheries vessel from the Canadian Coast Guard.

A number of changes in fishing gear type and vessels used occurred since the onset of sampling activities (Clark and Emberley 2011).
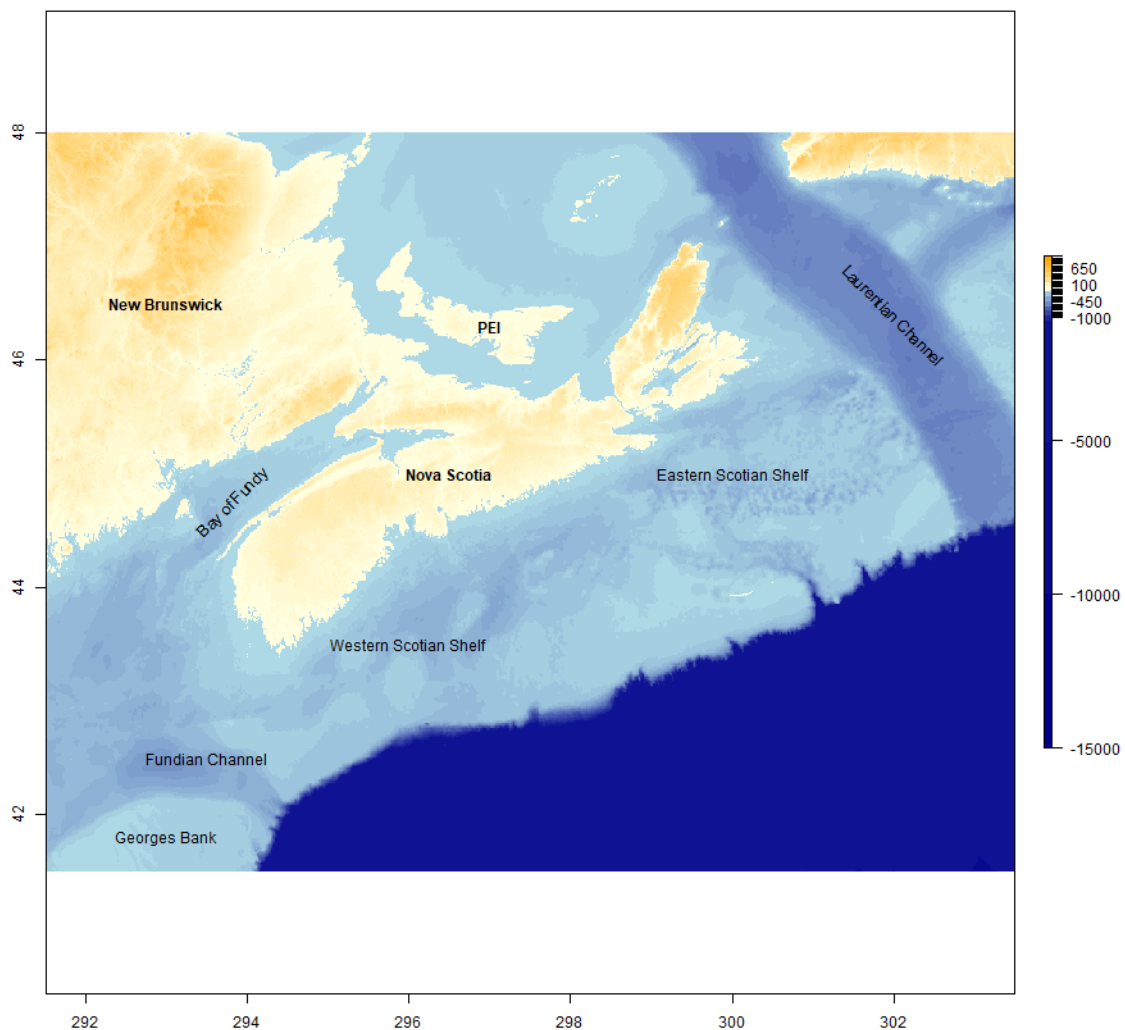
Figure 1. Map of the Scotian Shelf and Bay of Fundy.

2.2   Sampling Design

The summer survey covers divisions 4V, 4W and 4X of the Northwest Atlantic Fisheries Organization (NAFO) which includes the Scotian Shelf and the Bay of Fundy. The eastern limit of the survey is the Laurentian Channel and the western limit is the Fundian Channel (Figure 1).

The survey follows a stratified random design (Doubleday and Rivard 1981; Lohr 1999) (Figure 2). The number of tows conducted in each stratum is approximately proportional to its surface area.
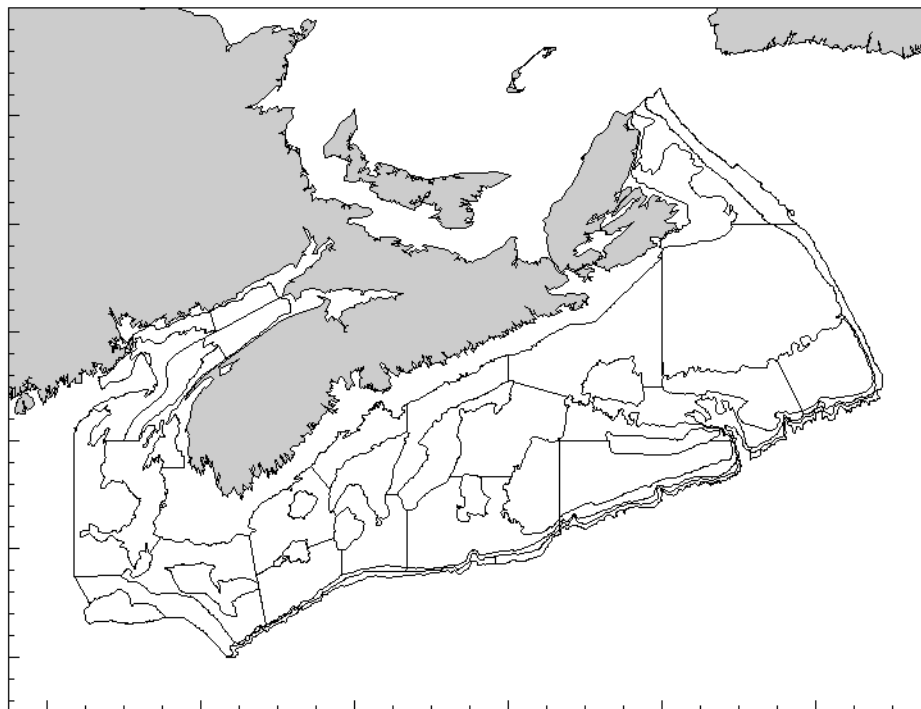
Figure 2. Map of the Summer survey strata.

The basic sampling unit of the survey is a 30-minute fishing tow conducted at a speed of 3.5 knots. This yields a distance towed of 1.75 nautical miles.

After each tow the catch is sorted by species and weighed. Each fish caught is then measured, and further sampling of individual fish weight, maturity status and age are performed for different length classes. When catches exceed 300 individuals, a random sub-sample is used to obtain the length and weight measurements.

The location of representative tows appears in Figure 3.
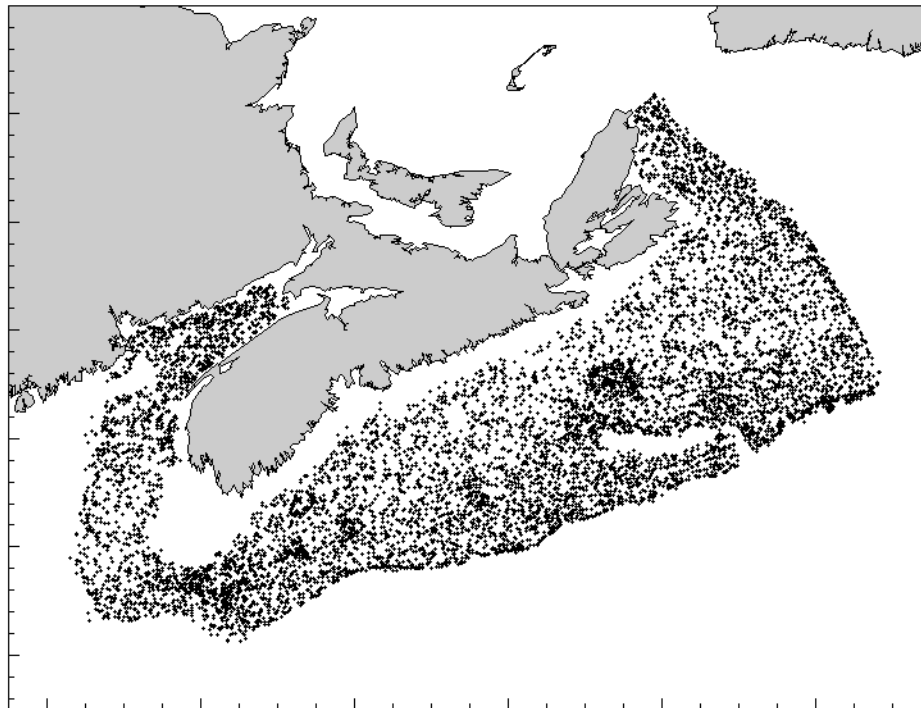
Figure 3. Map of the Summer survey tows.

2.3 Taxonomic Levels

Fish species caught during the surveys are identified by trained scientific personnel and their scientific name is determined. An internal species code used in the relational database is reported for each species (Losier and Waite 1989).

By its nature as a bottom trawl, the fishing gear used in the survey catches certain species better than others. To ensure that meaningful ecological information can be extracted from catch samples, we report the catch records for the subset of species that are caught reliably by the gear. To appear in this atlas, a species must have had a minimum of 10 observations over the duration of the survey activities. While both catch abundance and weight are recorded, the weight of species that appear at low abundances is often recorded as zero in the earlier parts of the survey when scales of appropriate precision were not available.

We divided the species caught into five categories based on 1) their taxonomic classification, 2) the number of recorded observations, and 3) their period of valid identification (Table 1). Category "LF", for "long frequent", was assigned to species that have more than 1000 records since 1970 and have been consistently identified since the onset of the survey. Category "LI", for "long intermediate", was assigned to species that had between 1000 and 200 catch records. Rare and elusive species (those with less than 200 catch records over the duration of the survey) are also reported but to a lower level of analytical details (Category "LR", for "long rare"). Category "SF", for "short frequent", was assigned to invertebrate species that were consistently sampled only since 1999 (Tremblay M. J. 2007). And category "SR", for "short rare" for invertebrate species consistently sampled only since 1999 and with less than 200 catch records. The list of taxa covered in this document is presented in phylogenetic order (Nelson J. S. et al. 2004) in Table 2. To ensure concordance with authoritative taxonomic information, the AphiaID from the World Register of Marine Species is also provided in Table 2 (Appeltans et al. 2012).

Category	Name	Description
L		long - consistently identified since the onset of the survey in 1970
LF	long frequent	species that have more than 1000 catch records
LI	long intermediate	species that had between 1000 and 200 catch records
LR	long rare	species with less than 200 catch records
S		short - invertebrate species that were consistently sampled only since 1999
SF	short frequent	species with more than 200 catch records
SR	short rare	species with less than 200 catch records

Table 1. Taxonomic levels

Table 2. List of species included in the Atlas. The species reported here are listed in phylogenetic order as per Page L. M. et al. (2013). For each taxonomic order and class, each species is listed in the table, its taxonomic family and scientific name is provided, along with its French and English common names, the species code used in the survey database, its AphiaID and a link to the World Registry of Marine Species, its number of catch records in the survey database and its classification category as defined in section 2.3.

	Family	Scientific name	English name	French name	Species code	AphiaID	Num. records	Category
Myxini								
Myxiniformes								
	Myxinidae	*Myxine glutinosa*	Atlantic hagfish	Myxine du nord	241	101170	804	LI
Petromyzonti								
Petromyzontiformes								
	Petromyzontidae	*Petromyzon marinus*	Sea lamprey	Lamproie marine	240	101174	16	LR
Actinopterygii								
Gadiformes								
	Gadidae	*Gadus morhua*	Atlantic cod	Morue franche	10	126436	5451	LF
		Melanogrammus aeglefinus	Haddock	Aiglefin	11	126437	5827	LF
	Phycidae	*Urophycis tenuis*	White hake	Merluche blanche	12	126504	3524	LF
		Urophycis chuss	Red hake	Merluche écureuil	13	126503	2195	LF
	Merlucciidae	*Merluccius bilinearis*	Silver hake	Merlu argenté	14	158962	4936	LF
	Lotidae	*Brosme brosme*	Cusk	Brosme	15	126447	688	LI
	Gadidae	*Pollachius virens*	Pollock	Goberge	16	126441	2787	LF
		Microgadus tomcod	Atlantic tomcod	Poulamon atlantique	17	158928	44	LR
	Merlucciidae	*Merluccius albidus*	Offshore silver hake	Merlu argenté du large	19	158748	161	LR
Scorpaeniformes								
	Sebastidae	*Sebastes*	Atlantic redfishes	Sébastes de l'Atlantique	23	126175	4152	LF
Pleuronectiformes								
	Pleuronectidae	*Hippoglossus hippoglossus*	Atlantic halibut	Flétan de l'Atlantique	30	127138	1634	LF

Family	Scientific name	English name	French name	Species code	AphiaID	Num. records	Category
	Reinhardtius hippoglossoides	Greenland halibut	Flétan noir	31	127144	736	LI
	Hippoglossoides platessoides	American plaice	Plie canadienne	40	127137	6023	LF
	Glyptocephalus cynoglossus	Witch flounder	Plie grise	41	127136	4301	LF
	Limanda ferruginea	Yellowtail flounder	Limande à queue jaune	42	158879	3233	LF
	Pseudopleuronectes americanus	Winter flounder	Limande-plie rouge	43	158885	1632	LF
Paralichthyidae	*Citharichthys arctifrons*	Gulf Stream flounder	Plie du Gulf Stream	44	158791	382	LI
Perciformes							
Anarhichadidae	*Anarhichas lupus*	Atlantic wolffish	Loup atlantique	50	126758	1572	LF
	Anarhichas minor	Spotted wolffish	Loup tacheté	51	126759	20	LR
	Anarhichas denticulatus	Northern wolffish	Loup à tête large	52	126757	17	LR
Clupeiformes							
Clupeidae	*Clupea harengus*	Atlantic herring	Hareng de l'Atlantique	60	126417	3487	LF
	Alosa sapidissima	American shad	Alose savoureuse	61	158670	468	LI
	Alosa pseudoharengus	Alewife	Gaspareau	62	158669	977	LI
Osmeriformes							
Osmeridae	*Osmerus mordax*	Rainbow smelt	Éperlan arc-en-ciel	63	126737	59	LR
	Mallotus villosus	Capelin	Capelan	64	126735	540	LI
Perciformes							
Scombridae	*Scomber scombrus*	Atlantic mackerel	Maquereau commun	70	127023	696	LI
Gadiformes							

	Family	Scientific name	English name	French name	Species code	AphiaID	Num. records	Category
	Phycidae	*Phycis chesteri*	Longfin hake	Merluche à longues nageoires	112	158988	784	LI
	Lotidae	*Enchelyopus cimbrius*	Fourbeard rockling	Motelle à quatre barbillons	114	126450	693	LI
Perciformes								
	Labridae	*Tautogolabrus adspersus*	Cunner	Tanche-tautogue	122	159785	82	LR
Scorpaeniformes								
	Sebastidae	*Helicolenus dactylopterus*	Blackbelly rosefish	Sébaste chèvre	123	127251	610	LI
Pleuronectiformes								
	Paralichthyidae	*Hippoglossina oblonga*	Fourspot flounder	Cardeau à quatre ocelles	142	158833	76	LR
	Scophthalmidae	*Scophthalmus aquosus*	Windowpane flounder	Turbot de sable	143	158907	115	LR
Aulopiformes								
	Chlorophthalmidae	*Parasudis truculenta*	Longnose greeneye	Oeil-vert à long nez	149	158868	45	LR
Myctophiformes								
	Myctophidae	*Myctophidae*	Lanternfishes	Poissons-lanternes	150	125498	160	LR
Aulopiformes								
	Chlorophthalmidae	*Chlorophthalmus agassizi*	Shortnose greeneye	Éperlan du large	156	126336	78	LR
Stomiiformes								
	Sternoptychidae	*Maurolicus muelleri*	Silvery lightfish	Brossé améthyste	158	127312	52	LR
	Stomiidae	*Stomias boa*	Boa dragonfish	Dragon-boa	159	127374	20	LR
Argentiniformes								
	Argentinidae	*Argentina silus*	Greater argentine	Grande argentine	160	126715	963	LI
Scorpaeniformes								
	Cottidae	*Myoxocephalus octodecemspinosus*	Longhorn sculpin	Chaboisseau à dix-huit épines	300	159520	3292	LF

Family	Scientific name	English name	French name	Species code	AphiaID	Num. records	Category
	Myoxocephalus scorpius	Shorthorn sculpin	Chaboisseau à épines courtes	301	127203	131	LR
	Myoxocephalus aenaeus	Grubby	Chaboisseau bronzé	303	159519	40	LR
	Triglops murrayi	Moustache sculpin	Faux-trigle armé	304	127205	1182	LF
	Artediellus uncinatus	Arctic hookear sculpin	Hameçon neigeux	306	127195	306	LI
Psychrolutidae	*Cottunculus microps*	Polar sculpin	Cotte polaire	307	127235	29	LR
Cottidae	*Icelus spatula*	Spatulate sculpin	Icèle spatulée	314	127200	40	LR
Hemitripteridae	*Hemitripterus americanus*	Sea raven	Hémitriptère atlantique	320	159518	2126	LF
Agonidae	*Aspidophoroides monopterygius*	Alligatorfish	Poisson-alligator atlantique	340	159459	1029	LF
	Ulcina olrikii	Arctic alligatorfish	Poisson-alligator arctique	341	274356	13	LR
	Leptagonus decagonus	Atlantic poacher	Agone atlantique	350	127191	266	LI
	Agonidae	Alligatorfishes	Poissons-alligator	351	125588	43	LR
Lophiiformes							
Lophiidae	*Lophius americanus*	Monkfish	Baudroie d'Amérique	400	159184	1970	LF
Gadiformes							
Macrouridae	*Nezumia bairdii*	Marlin-spike grenadier	Grenadier du Grand Banc	410	183289	529	LI
	Trachyrincus murrayi	Roughnose grenadier	Grenadier-scie	412	126481	18	LR
	Coryphaenoides rupestris	Roundnose grenadier	Grenadier de roche	414	158960	17	LR
Scorpaeniformes							
Cyclopteridae	*Cyclopterus lumpus*	Lumpfish	Lompe	501	127214	216	LI

Family	Scientific name	English name	French name	Species code	AphiaID	Num. records	Category
	Eumicrotremus spinosus	Atlantic spiny lumpsucker	Petite poule de mer atlantique	502	127217	226	LI
Liparidae	*Liparis atlanticus*	Atlantic seasnail	Limace atlantique	503	159524	34	LR
	Liparis fabricii	Gelatinous snailfish	Limace gélatineuse	505	127218	27	LR
	Liparis gibbus	Variegated snailfish	Limace marbée	512	159526	41	LR
	Careproctus reinhardti	Sea tadpole	Petite limace de mer	520	127212	18	LR
Perciformes							
Zoarcidae	*Lycenchelys verrillii*	Wolf eelpout	Lycode à tête longue	603	159258	40	LR
Anguilliformes							
Nemichthyidae	*Nemichthys scolopaceus*	Slender snipe eel	Avocette ruban	604	126306	28	LR
Perciformes							
Ammodytidae	*Ammodytes dubius*	Sand lance	Lançon	610	151520	1283	LI
Zoarcidae	*Lycodes terraenovae*	Newfoundland eelpout	Lycode du Labrador	619	127117	64	LR
	Lycodes lavalaei	Newfoundland eelpout	Lycode du Labrador	620	127107	72	LR
Pholidae	*Pholis gunnellus*	Rock gunnel	Sigouine de roche	621	126996	21	LR
Stichaeidae	*Lumpenus lampretaeformis*	Snakeblenny	Lompénie-serpent	622	154675	423	LI
	Leptoclinus maculatus	Daubed shanny	Lompénie tachetée	623	127072	443	LI
	Ulvaria subbifurcata	Radiated shanny	Ulvaire deux-lignes	625	159821	145	LR
	Eumesogrammus praecisus	Fourline snakeblenny	Quatre-lignes atlantique	626	159817	40	LR
Cryptacanthodidae	*Cryptacanthodes maculatus*	Wrymouth	Terrassier tacheté	630	159675	120	LR
Callionymidae	*Foetorepus agassizii*	Spotfin dragonet	Dragonnet tacheté	637	276339	20	LR

	Family	Scientific name	English name	French name	Species code	AphiaID	Num. records	Category
	Zoarcidae	*Zoarces americanus*	Ocean pout	Loquette d'Amérique	640	159267	1478	LF
		Lycodes reticulatus	Arctic eelpout	Lycode arctique	641	127112	70	LR
		Melanostigma atlanticum	Atlantic soft pout	Molasse atlantique	646	127120	43	LR
		Lycodes vahlii	Vahl's eelpout	Lycode à carreaux	647	127118	565	LI
	Stromateidae	*Peprilus triacanthus*	Atlantic butterfish	Stromaté fossette	701	159828	487	LI
Zeiformes	Zeidae	*Zenopsis conchifer*	Silvery John dory	Saint Pierre argenté	704	127426	39	LR
Aulopiformes	Paralepididae	*Arctozenus risso*	White barracudina	Lussion blanc	712	126352	196	LR
Beloniformes	Scomberesocidae	*Scomberesox saurus*	Atlantic saury	Balaou atlantique	720	126392	37	LR
Stomiiformes	Sternoptychidae	*Sternoptychidae*	Hatchetfishes	Haches d'argent	741	125603	21	LR
Lophiiformes	Ogcocephalidae	*Dibranchus atlanticus*	Atlantic batfish	Malthe atlantique	742	126558	18	LR
Pleuronectiformes	Cynoglossidae	*Symphurus diomedeanus*	Spottedfin tonguefish	Langue fil noir	816	159358	24	LR
Scorpaeniformes	Cottidae	*Artediellus atlanticus*	Atlantic hookear sculpin	Hameçon atlantique	880	127193	258	LI
Elasmobranchii								
Rajiformes	Rajidae	*Dipturus laevis*	Barndoor skate	Grande raie	200	158548	246	LI
		Amblyraja radiata	Thorny skate	Raie épineuse	201	105865	3937	LF
		Malacoraja senta	Smooth skate	Raie lisse	202	158554	1773	LF

Family	Scientific name	English name	French name	Species code	AphiaID	Num. records	Category
	Leucoraja erinacea	Little skate	Raie hérisson	203	158551	712	LI
	Leucoraja ocellata	Winter skate	Raie tachetée	204	158553	1180	LF
Squaliformes							
Squalidae	*Squalus acanthias*	Picked dogfish	Aiguillat commun	220	105923	1985	LF
Etmopteridae	*Centroscyllium fabricii*	Black dogfish	Aiguillat noir	221	105906	31	LR
Cephalopoda							
Oegopsida							
Ommastrephidae	*Illex illecebrosus*	Northern shortfin squid	Encornet rouge nordique	4511	153087	4836	LF
Myopsida							
Loliginidae	*Doryteuthis pealeii*	Longfin inshore squid	Calmar totam	4512	574541	96	LR
Malacostraca							
Decapoda							
Pandalidae	*Pandalus borealis*	Northern prawn	Crevette nordique	2211	107649	718	SF
Cancridae	*Cancer borealis*	Jonah crab	Tourteau jona	2511	158056	1387	SF
	Cancer irroratus	Atlantic rock crab	Tourteau poïnclos	2513	158057	788	SF
Oregoniidae	*Hyas coarctatus*	Arctic lyre crab	Crabe Hyas coarctatus	2521	107323	711	SF
Lithodidae	*Lithodes maja*	Atlantic king crab	Crabe épineux du nord	2523	107205	531	SF
Oregoniidae	*Chionoecetes opilio*	Queen crab	Crabe des neiges	2526	107315	1546	SF
	Hyas araneus	Great spider crab	Crabe lyre araignée	2527	107322	625	SF
Geryonidae	*Chaceon quinquedens*	Red deepsea crab	Crabe rouge	2532	158407	33	SR
Nephropidae	*Homarus americanus*	American lobster	Homard américain	2550	156134	1623	SF

2.4 Analyses

The Oracle relational database where all data are stored was accessible from the Bedford Institute of Oceanography in Dartmouth, Nova Scotia. Structured Query Language (SQL) is used to extract the data from the production server and to create the data products used in all subsequent analyses. Catch records classified as "valid" (i.e. a representative tow without damage to the net) are used in the current analyses. To make the available samples comparable, catch number and weight for each species was standardized for the distance towed.

All data processing and analyses were conducted using the R software (R Core Team 2020) using packages gstat (Pebesma 2004), PBSmapping (Schnute et al. 2019), RODBC (Ripley and Lapsley 2019), spatstat (Baddeley 2015), maptools (Bivand and Lewin-Koh 2020), rgeos (Bivand and Rundel 2020), classInt(Bivand 2020), RColorBrewer(Neuwirth 2014), MASS (Ripley et al. 2020), worms (Holstein 2018), and tidyverse (Wickham 2019). The present document is rendered as a Technical Report using the csasdown R package developed and maintained by Fisheries and Oceans Canada scientists (Anderson et al. In press).

2.4.1 Geographic distribution of catches

Spatial interpolation of catch biomass (kg/tow) or abundance (number/tow) was done using a weighting inversely proportional to the distance, using function "idw" of the spatstat R package (Baddeley 2015).

2.4.2 Abundance and biomass indices

For each species, stratified random estimates of catch abundance and biomass (Smith 1996) were computed for each year. Yearly estimates of the standard error were also computed.

2.4.3 Distribution indices

For each Category L, I and S fish species, the minimum area required to account for 75% and 95% of the total biomass or abundance were computed (D75% and D95%). These measures of distributions were computed for each year by using the Lorenz curve of mean stratum-level catch estimates and the area of occupied strata (Swain and Sinclair 1994; Swain and Morin 1996).

2.4.4 Length frequencies

The length frequency distribution of catch is tabulated for each seven-year period (1970-2009), and last ten-year period (2010-2020).

2.4.5 Length-weight relationship and condition factor

The relationship between the weight and the length of fish was estimated using the following non-linear isometric relationship:

$$W = \alpha L^\beta$$

where W is the total weight (g), L is the length (cm), and, α and β are the parameters to be estimated.

Average fish condition (C) was computed as:

$$C = \frac{W}{\alpha L^\beta}$$

2.4.6 Depth, temperature and salinity distribution of catches

For each category L species, We followed the methods developed by (Perry and Smith 1994) and generated cumulative frequency distributions of depth, temperature and salinity of survey catches.

2.4.7 Density-dependent habitat selection

We followed the methods of (Myers and Stokes 1989) to evaluate how fish abundance in each stratum varied with overall temporal fluctuations of population abundance.

For each category L species, we fitted a model of the relationship between stratum-level density and overall abundance (the yearly stratified random estimate of abundance, defined above). To properly use the observations of zero catch while accounting for the logarithmic distribution of catch abundance, we implemented the model as a generalised linear using a log link and a Poisson error distribution:

$$Y_{h,i} = \alpha_h Y_i^{\beta_h}$$

where, $y_{h,i}$ is the average abundance of stratum h in year i, and $\alpha_{h,i}$ and $\beta_{h,i}$ are the fitted parameters. The estimated parameter $\beta_{h,i}$ is referred to as the "slope parameter" and indicates whether stratum-level density is positively ($\beta_{h,i} <= 0$), negatively ($\beta_{h,i} >= 0$) or negligibly ($\beta_{h,i} \approx 0$) related to population abundance.

To estimate the suitability of each stratum, the median abundance observed during the years that are in the top 25% of yearly estimates is used. We combine the slope parameter estimates from the above model with the median abundance to identify strata that have consistently high abundance and whose local density is weakly related to fluctuation in population abundance ($\beta_{h,i} \approx 0$). Preferred strata are identified for each category L species.

3 Results

The plots generated for each species are presented in the Appendix.

3.1 Description of Figures

3.1.1 Type A

For Category L and S species:

Spatial distribution of catch-per unit of effort, (CPUE, kilograms per tow) in July-August for the Bay of Fundy and Scotian Shelf in five-year periods. Spatial interpolation between tows was done using Inverse Distance Weight (IDW). The probability of occurrence (proportion of tows with catch records for a given species) was also reported for each five-year period.

For Category LR and SR:

Location of tows with catch over the period 1970-2012 (Type LR) or the period 1999-2012 (Type SR). Location of tows with catch over the period 1970-2012 (Type LR) or the period 1999-2012 (Type SR).

3.1.2 Type B

For Category L, S and I species:

Stratified random estimate of CPUE (left panel), distribution indices (D75% and D95%, the minimum area containing 75% and 95% of biomass, middle panel), and distribution vs. weight per tow (right panel). The stratified random mean is plotted as a solid line with the 95% confidence region indicated by the solid grey line. The overall mean is plotted as a grey horizontal line and the overall mean plus or minus 50% of the standard deviation appear as horizontal dashed lines. In all three panels, the early years appear in blue and the last years appear in red. The predictions from a loess estimator are overlaid on the distribution indices (middle panel). The Pearson correlation coefficient between D75% and biomass, and its statistical significance, are also reported in the right panel.

3.1.3 Type C.

Length frequency distribution for NAFO divisions 4X and 4VW. A smoothed length frequency distribution is shown for each 7-year periods covered by the surveys.

3.1.4   Type D.

Average fish condition for all fish lengths (black dots and black line), large fish (thick gray line), and small fish (thin gray line). Fish condition is presented for NAFO divisions 4VW (right panel) and 4X (left panel).

3.1.5   Type E.

Cumulative frequency distributions of depth, temperature and salinity at all sampled locations (thick solid line) and at fishing locations with catch records (thin dashed line). The depth, temperature and salinity associated with 5%, 25%, 50%, 75% and 95% of the cumulative catch is shown in tabular fashion on the bottom right panel.

3.1.6   Type F.

Slopes estimates from the density-dependent habitat selection model (y axis) plotted versus the median abundance during the top 25% of years. The red box indicates strata of particular importance for a species by identifying slopes that are within a standard error from zero and that are within the top 25% of median abundance. Each stratum is identified on the plot by the last two digits of its number.

3.2   Summary of successful tows by year and stratum

There is something weird going on here, there are 2 tows with NAs for stratum, (HAM1980042 set 62 and HAM1982072 set 13).

Table 3. Number of representative tows conducted in each stratum during the period 1970 to 1991.

Stratum	NAFO Div.	Area (km2)	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
440	4VN	3173.016	4	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	5	5	6	4	4	4
441	4VN	3434.000	4	2	2	3	3	3	1	3	3	3	3	3	3	3	3	5	5	4	4	4	6	5
442	4VN	4934.658	3	2	2	2	3	3	2	3	3	3	3	3	3	3	3	3	5	6	7	5	5	5
443	4VSW	4526.012	4	2	4	4	8	3	1	2	4	4	4	3	5	4	4	4	6	6	5	2	4	2
444	4VSW	13478.450	3	2	5	4	6	4	6	7	4	4	4	5	5	6	4	4	6	6	3	6	7	8
445	4VSW	3512.982	5	2	5	4	5	5	1	3	4	4	4	5	5	3	4	5	6	4	4	4	4	4
446	4VSW	1686.094	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	3	3	3	3	3
447	4VSW	5549.344	4	2	6	5	7	4	4	3	4	4	5	4	4	4	4	4	5	7	6	6	8	7
448	4VSW	4975.866	5	2	5	4	5	4	4	4	4	4	4	6	4	4	4	4	5	5	5	5	9	6
449	4VSW	494.496	2	2	2	2	3	2	2	2	1	2	2	2	1	2	2	2	2	2	2	2	2	2
450	4VSW	1315.222	2	2	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
451	4VSW	504.798	1	2	2	2	2	2	2	2	2	3	2	2	3	2	2	2	2	2	2	2	2	2
452	4VSW	1184.730	2	2	2	2	2	2	2	2	2	2	2	4	2	2	2	2	2	3	2	2	3	2
453	4VSW	889.406	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	3	2
454	4VSW	1713.566	3	2	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	2	2	2	3	2
455	4VSW	7286.948	7	6	7	6	7	6	6	7	7	7	7	7	7	7	7	7	8	8	7	7	12	10
456	4VSW	3279.470	5	4	6	5	5	6	4	6	6	6	6	7	6	6	6	6	6	7	6	6	10	7
457	4VSW	2784.974	2	2	2	2	3	2	2	2	2	2	2	3	2	2	2	2	2	4	2	2	4	2
458	4VSW	2259.572	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	5	5	3	3	9	8
459	4VSW	10810.232	3	2	4	4	4	4	4	4	4	4	4	4	3	4	4	6	6	5	6	5	5	5
460	4VSW	4615.296	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	4	3	3	3	3	3
461	4VSW	3962.836	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	2	2	1	2
462	4VSW	7266.344	3	3	4	3	4	4	4	4	4	4	6	4	4	4	4	4	6	5	4	4	5	5
463	4VSW	1037.068	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2	3	2
464	4VSW	4453.898	4	3	5	3	3	6	5	5	5	5	5	5	4	5	5	5	7	6	5	5	9	7
465	4VSW	8183.222	6	5	5	4	5	4	5	5	5	5	5	7	6	5	5	5	5	8	8	8	12	9
466	4VSW	776.084	2	2	3	2	3	3	3	3	3	3	3	2	3	3	3	3	3	2	2	2	3	2
470	4X	3159.280	1	2	2	2	3	2	2	2	2	2	2	2	2	2	2	2	3	3	3	2	2	2
471	4X	3447.736	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
472	4X	4289.066	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	4	4	4	6	4
473	4X	910.010	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2
474	4X	552.874	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	2	2	2	2	2	2	2
475	4X	535.704	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
476	4X	5075.452	2	2	2	2	2	3	2	2	2	1	2	2	2	2	2	2	2	4	4	4	4	4
477	4X	4230.688	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	5	4	4	5	5
478	4X	800.122	2	2	3	2	3	3	3	3	2	3	3	3	3	3	3	3	2	2	2	2	2	2
480	4X	2249.270	4	4	4	3	3	3	4	4	3	4	3	3	4	4	4	4	4	4	4	4	8	8
481	4X	6438.750	5	3	4	4	4	3	4	4	5	4	3	4	4	4	4	4	4	6	7	6	8	9
482	4X	3578.228	2	1	2	2	2	2	3	2	2	3	2	2	2	2	2	2	2	3	3	3	3	3
483	4X	1826.888	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
484	4X	7774.576	2	2	3	3	3	3	3	3	2	3	3	3	4	3	3	3	3	4	4	4	3	3
485	4X	5432.588	2	2	2	3	3	3	3	3	3	3	2	3	4	3	3	3	3	6	7	6	2	3
490	4X	2063.834	2	2	2	2	2	3	3	3	3	2	3	3	3	3	3	3	3	4	4	4	4	4
491	4X	2359.158	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	3	3
492	4X	3729.324	3	2	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	3	3
493	4X	1830.322	1	2	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
494	4X	1431.978	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
495	4X	2005.456	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2
		171809.888	134	110	146	134	153	143	135	144	141	147	145	150	150	146	143	152	171	188	177	170	213	189

Table 4. Number of representative tows conducted in each stratum during the period 1992 to 2013.

Stratum	NAFO Div.	Area (km2)	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
440	4VN	3173.016	4	3	4	4	4	4	4	4	6	4	4	4	4	4	4	4	3	4	4	5	4	4
441	4VN	3434.000	5	5	5	5	5	5	5	6	7	6	6	7	6	7	6	6	5	6	6	7	6	6
442	4VN	4934.658	6	5	6	6	6	6	6	7	6	6	5	6	6	7	5	5	5	6	5	6	6	6
443	4VSW	4526.012	4	3	3	4	4	5	5	4	5	4	5	5	5	4	4	4	5	4	4	6	5	5
444	4VSW	13478.450	8	9	6	8	8	7	8	8	9	10	9	9	9	8	10	8	6	9	11	13	9	8
445	4VSW	3512.982	4	5	7	4	4	4	3	3	6	5	5	5	5	6	5	4	3	6	4	7	2	4
446	4VSW	1686.094	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	4	3	3
447	4VSW	5549.344	7	7	7	7	6	7	7	6	7	7	7	7	7	7	6	6	4	6	6	8	6	7
448	4VSW	4975.866	6	7	7	7	6	7	6	7	8	8	8	8	7	8	8	6	5	7	7	10	8	8
449	4VSW	494.496	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	4	2	2
450	4VSW	1315.222	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
451	4VSW	504.798	2	2	2	2	4	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2
452	4VSW	1184.730	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2	2	2	2
453	4VSW	889.406	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	1	2	2	1	3	2	2
454	4VSW	1713.566	2	2	2	2	3	2	2	2	2	2	2	2	3	2	2	2	2	2	2	4	2	2
455	4VSW	7286.948	10	9	10	10	10	13	8	11	11	11	11	11	8	12	11	7	5	8	10	10	10	11
456	4VSW	3279.470	7	8	8	8	8	8	6	8	10	8	8	8	8	8	8	6	2	7	7	9	8	8
457	4VSW	2784.974	2	2	2	2	2	2	2	1	4	2	2	2	2	2	2	2	2	2	2	4	2	2
458	4VSW	2259.572	8	8	8	8	7	8	5	6	10	8	7	8	8	10	8	5	2	7	6	9	8	6
459	4VSW	10810.232	6	4	6	6	4	5	6	6	8	6	6	6	6	6	6	5	3	6	6	7	6	6
460	4VSW	4615.296	3	3	3	3	3	3	3	3	3	3	4	3	3	4	3	2	3	3	3	4	4	3
461	4VSW	3962.836	2	2	2	2	2	2	2	2	2	2	2	2	2	4	2	2	2	2	2	3	3	2
462	4VSW	7266.344	4	4	4	4	4	4	4	4	4	4	4	4	4	5	4	3	4	4	4	6	4	4
463	4VSW	1037.068	2	2	2	2	2	2	2	2	2	2	3	2	2	4	2	2	2	2	2	3	2	2
464	4VSW	4453.898	7	7	7	7	7	4	7	7	7	7	7	7	5	8	7	6	4	5	6	7	7	7
465	4VSW	8183.222	10	10	10	10	10	10	9	10	10	10	10	10	10	10	10	7	8	7	8	10	10	10
466	4VSW	776.084	2	2	2	3	2	2	3	2	2	2	2	2	2	2	2	1	3	2	2	2	2	2
470	4X	3159.280	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	2
471	4X	3447.736	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	2
472	4X	4289.066	4	4	4	4	3	4	4	4	4	4	4	4	4	4	4	3	4	3	4	6	4	4
473	4X	910.010	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2	2
474	4X	552.874	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
475	4X	535.704	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2	2
476	4X	5075.452	4	4	4	4	4	4	4	4	4	4	5	4	4	4	4	4	4	4	4	4	4	4
477	4X	4230.688	5	5	5	5	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	4	5	5
478	4X	800.122	2	2	2	3	3	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2
480	4X	2249.270	8	8	8	8	8	8	8	8	7	8	8	8	7	9	8	6	8	8	8	7	8	8
481	4X	6438.750	9	9	9	7	9	9	9	9	8	9	8	9	6	12	9	7	8	8	8	10	9	9
482	4X	3578.228	3	3	3	3	3	3	3	3	3	3	3	3	2	4	3	3	3	3	3	4	3	3
483	4X	1826.888	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2
484	4X	7774.576	3	3	3	3	3	3	3	3	3	3	4	3	3	4	4	3	3	4	3	5	5	5
485	4X	5432.588	3	3	3	3	3	3	3	3	4	3	5	5	3	2	5	4	5	5	5	6	5	5
490	4X	2063.834	4	4	4	5	4	4	4	3	4	4	4	6	4	3	3	3	4	3	3	4	2	4
491	4X	2359.158	3	3	3	3	3	3	3	3	3	3	3	5	3	3	4	3	4	4	4	4	4	4
492	4X	3729.324	3	3	3	2	3	3	3	3	3	3	3	5	2	3	4	4	4	4	4	6	4	4
493	4X	1830.322	3	3	3	3	2	3	3	2	3	3	4	5	2	4	4	3	3	4	3	4	4	4
494	4X	1431.978	2	2	2	2	2	2	2	2	2	2	3	4	2	2	4	3	3	4	4	4	4	4
495	4X	2005.456	2	2	2	2	2	2	2	2	2	2	2	4	2	2	5	3	3	4	3	4	4	4
		171809.888	193	190	195	195	191	193	186	191	213	201	208	216	188	222	209	177	165	196	196	243	210	208

Table 5. Number of representative tows conducted in each stratum during the period 2014 to 2020 and for the whole 1970 to 2020 period.

Stratum	NAFO Div.	Area (km2)	2014	2015	2016	2017	2018	2019	2020	Total
440	4VN	3173.016	4	4	4	4	0	5	4	190
441	4VN	3434.000	6	6	6	6	0	7	4	238
442	4VN	4934.658	6	6	6	6	0	6	5	240
443	4VSW	4526.012	3	7	4	5	0	9	4	214
444	4VSW	13478.450	9	9	11	10	0	6	8	352
445	4VSW	3512.982	3	4	4	4	0	6	3	215
446	4VSW	1686.094	3	2	3	2	0	3	2	145
447	4VSW	5549.344	7	7	7	7	0	6	5	291
448	4VSW	4975.866	8	7	6	6	0	7	4	299
449	4VSW	494.496	2	2	2	2	0	2	2	100
450	4VSW	1315.222	3	3	3	2	0	3	2	144
451	4VSW	504.798	2	2	2	2	0	2	2	104
452	4VSW	1184.730	1	4	3	3	0	3	3	110
453	4VSW	889.406	3	2	2	1	0	2	2	116
454	4VSW	1713.566	2	2	2	2	0	3	2	121
455	4VSW	7286.948	11	9	9	8	0	9	6	429
456	4VSW	3279.470	6	5	6	6	0	6	4	331
457	4VSW	2784.974	2	3	3	3	0	3	2	113
458	4VSW	2259.572	4	5	5	5	0	6	3	269
459	4VSW	10810.232	6	7	7	6	0	9	7	262
460	4VSW	4615.296	3	5	5	5	3	6	5	151
461	4VSW	3962.836	2	3	3	3	2	3	3	113
462	4VSW	7266.344	5	5	5	5	0	5	5	212
463	4VSW	1037.068	2	3	2	2	0	2	2	107
464	4VSW	4453.898	7	6	6	4	0	6	4	288
465	4VSW	8183.222	10	10	9	7	3	10	7	397
466	4VSW	776.084	2	2	2	3	0	3	2	118
470	4X	3159.280	2	3	3	3	4	3	2	112
471	4X	3447.736	2	3	3	3	4	4	3	110
472	4X	4289.066	4	4	4	4	4	4	4	172
473	4X	910.010	2	2	2	2	2	2	2	104
474	4X	552.874	2	2	2	2	2	2	2	100
475	4X	535.704	2	2	2	2	2	2	2	103
476	4X	5075.452	4	5	5	5	5	5	5	177
477	4X	4230.688	6	5	5	4	4	6	4	204
478	4X	800.122	2	2	2	3	2	2	2	119
480	4X	2249.270	6	7	7	7	5	7	5	306
481	4X	6438.750	9	8	10	9	6	9	6	350
482	4X	3578.228	3	3	4	4	3	4	3	141
483	4X	1826.888	2	2	3	3	2	3	2	105
484	4X	7774.576	4	6	5	7	7	7	7	186
485	4X	5432.588	5	6	6	6	4	6	5	196
490	4X	2063.834	3	4	4	4	3	4	3	173
491	4X	2359.158	4	4	4	4	3	4	3	168
492	4X	3729.324	4	3	4	4	3	4	4	171
493	4X	1830.322	3	3	4	6	3	3	3	159
494	4X	1431.978	3	4	4	3	2	4	3	128
495	4X	2005.456	2	4	4	4	3	4	3	127
		171809.888	196	212	214	208	81	227	175	9080

A total of 9080 representative tows were conducted for the period spanning from 1970 to 2020.

4   Discussion

The current document is not meant to replace stock assessments, species-specific analyses of abundance, biomass and distribution, or any targeted attempts to integrate information about species or group of species from the wide and disparate sources of data about marine organisms in the area covered by the DFO Maritimes summer trawl survey. It is rather meant to provide a reproducible set of tools to extract and visualise the information collected in the DFO Maritimes summer trawl survey.

It is hoped that this document can provide a stepping stone to conduct other ecological analyses using the trawl survey data.

5   Acknowledgements

We thank all the dedicated personnel involved in running trawl surveys in the Maritimes Region.

6   References

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7 Appendix

7.1 Northern prawn (Crevette nordique) - species code 2211 (category SF)

Scientific name: Pandalus borealis

1999–2020

P(occ) = 0.15

n = 655
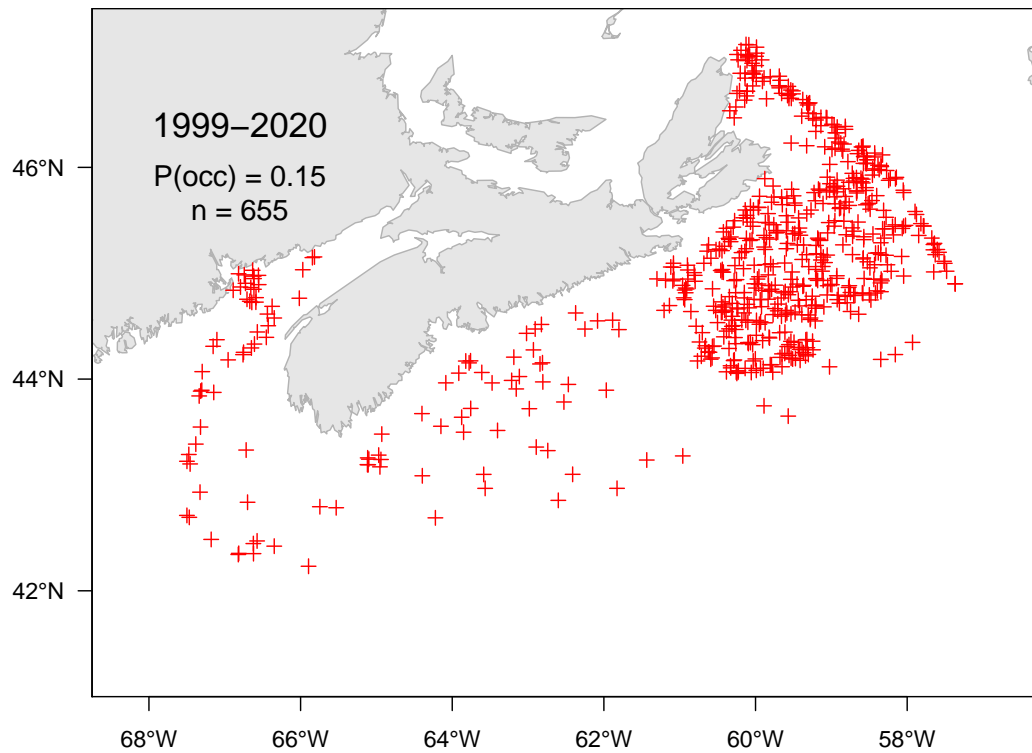
Figure 7.1A. Catch distribution for Northern prawn.

7.2 Jonah crab (Tourteau jona) - species code 2511 (category SF)

Scientific name: Cancer borealis
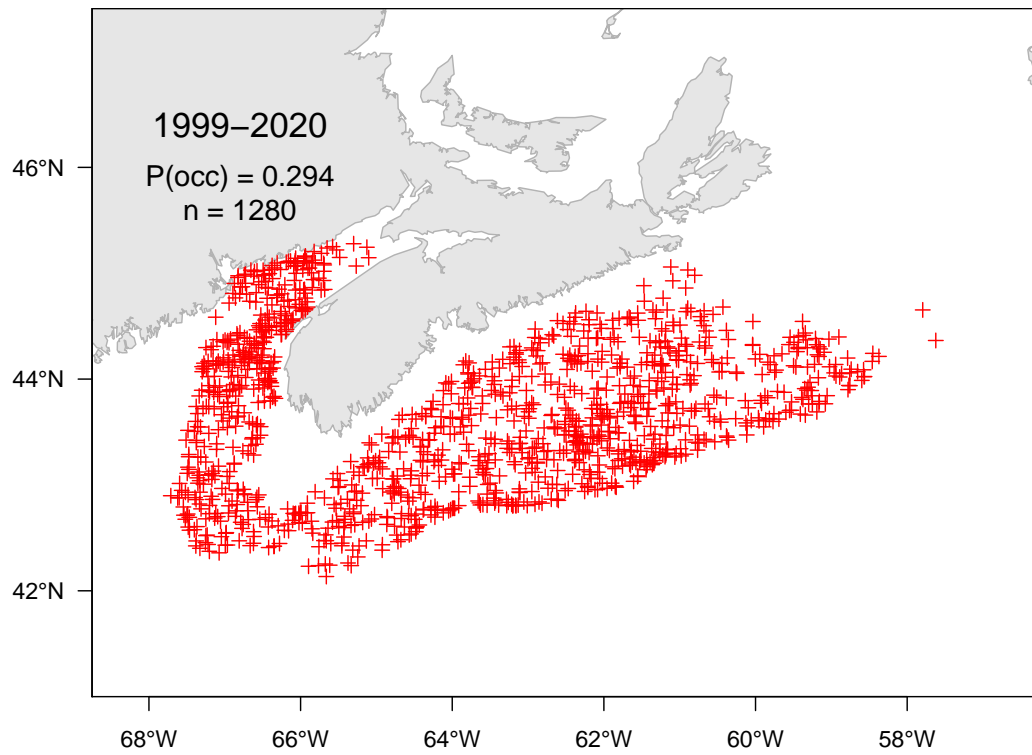
Figure 7.2A. Catch distribution for Jonah crab.

7.3 Atlantic rock crab (Tourteau poïnclos) - species code 2513 (category SF)

Scientific name: Cancer irroratus
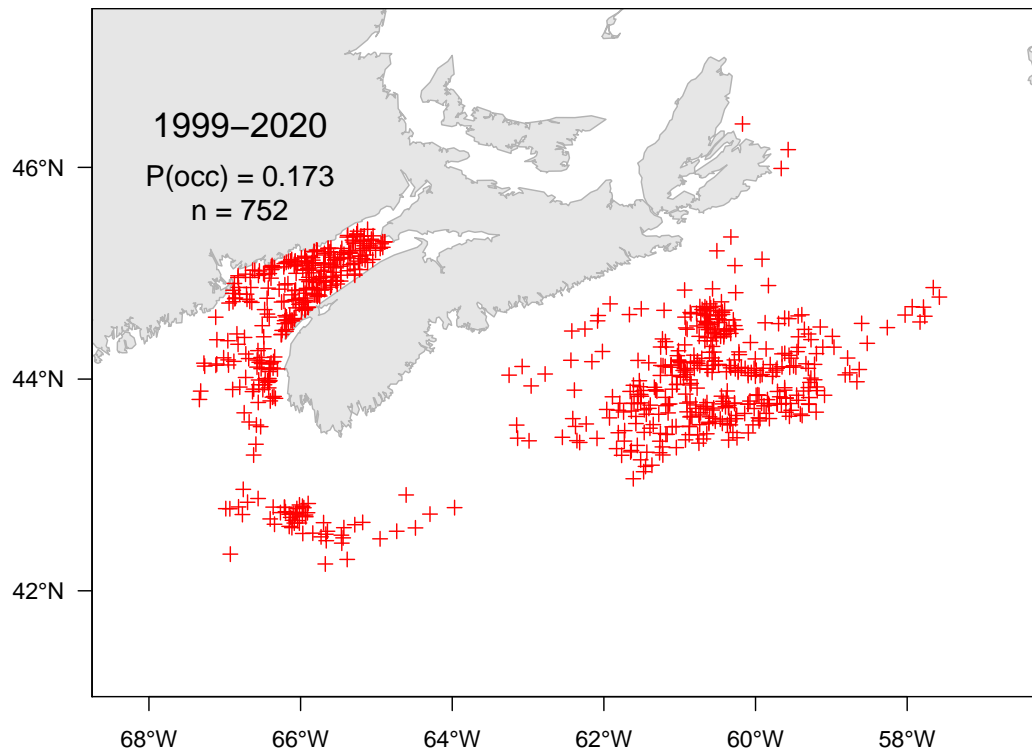
Figure 7.3A. Catch distribution for Atlantic rock crab.

7.4 Arctic lyre crab (Crabe Hyas coarctatus) - species code 2521 (category SF)

Scientific name: Hyas coarctatus
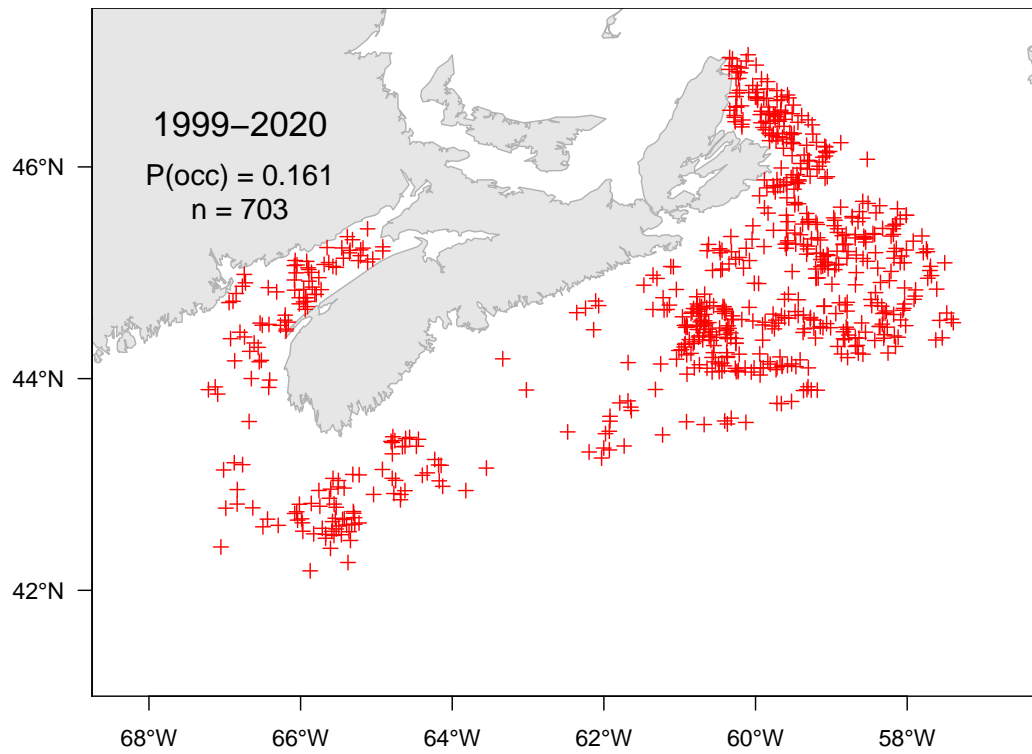
Figure 7.4A. Catch distribution for Arctic lyre crab.

7.5 Atlantic king crab (Crabe épineux du nord) - species code 2523 (category SF)

Scientific name: Lithodes maja

1999–2020
P(occ) = 0.115
n = 502
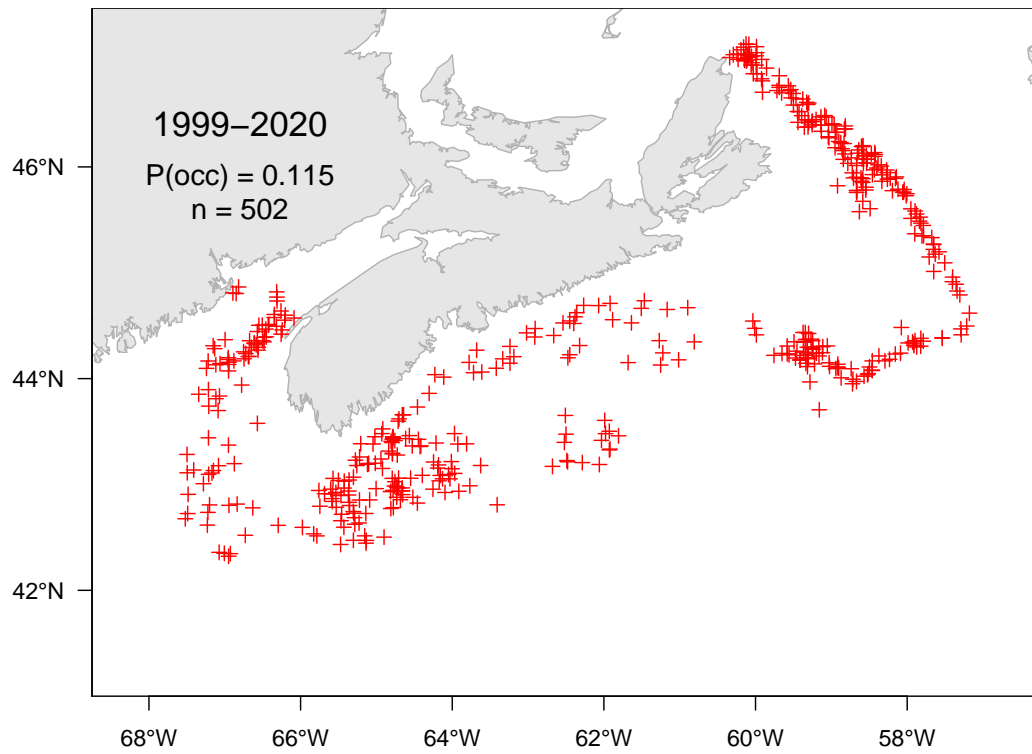
Figure 7.5A. Catch distribution for Atlantic king crab.

7.6 Queen crab (Crabe des neiges) - species code 2526 (category SF)

Scientific name: Chionoecetes opilio
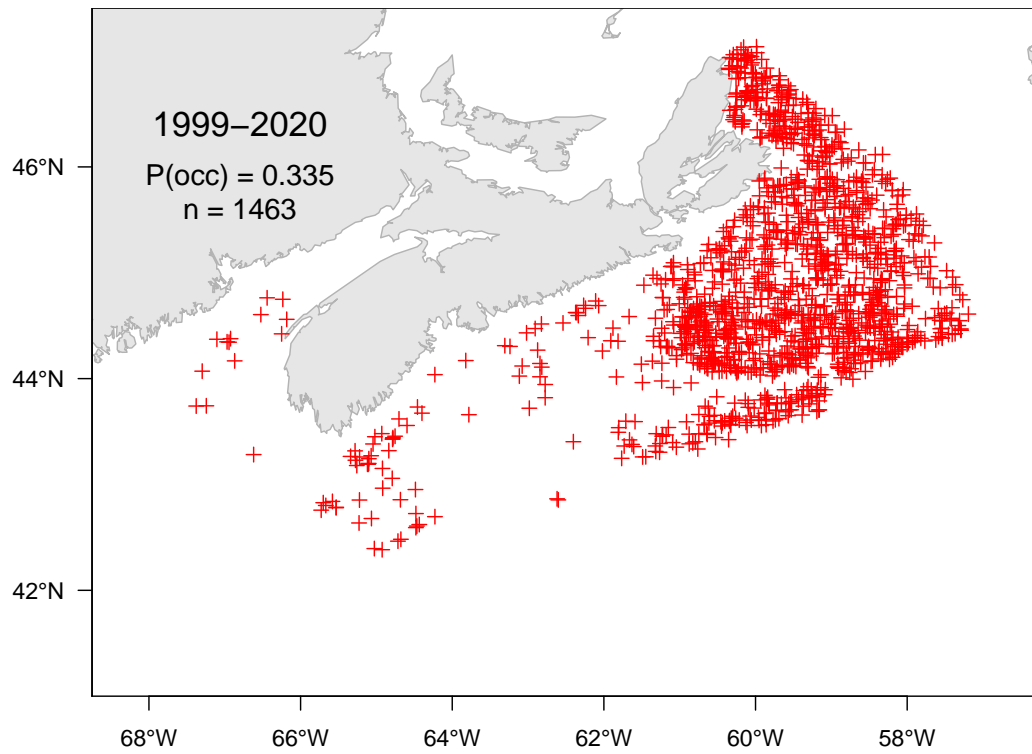
Figure 7.6A. Catch distribution for Queen crab.

7.7 Great spider crab (Crabe lyre araignée) - species code 2527 (category SF)

Scientific name: Hyas araneus
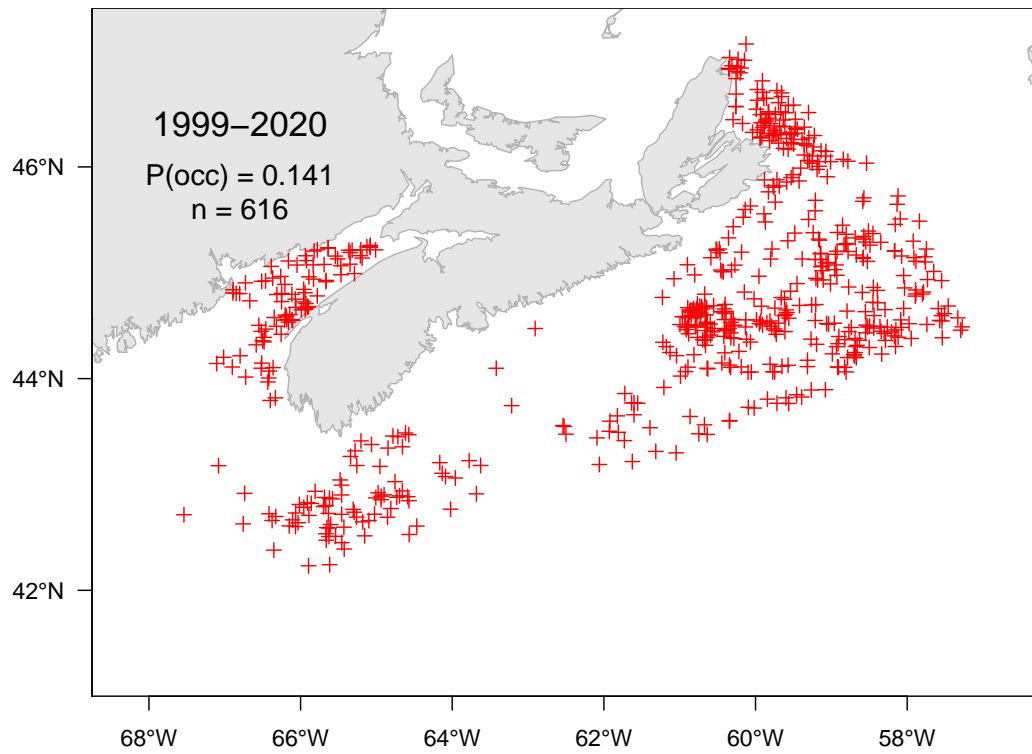
Figure 7.7A. Catch distribution for Great spider crab.

7.8 American lobster (Homard américain) - species code 2550 (category SF)

Scientific name: Homarus americanus
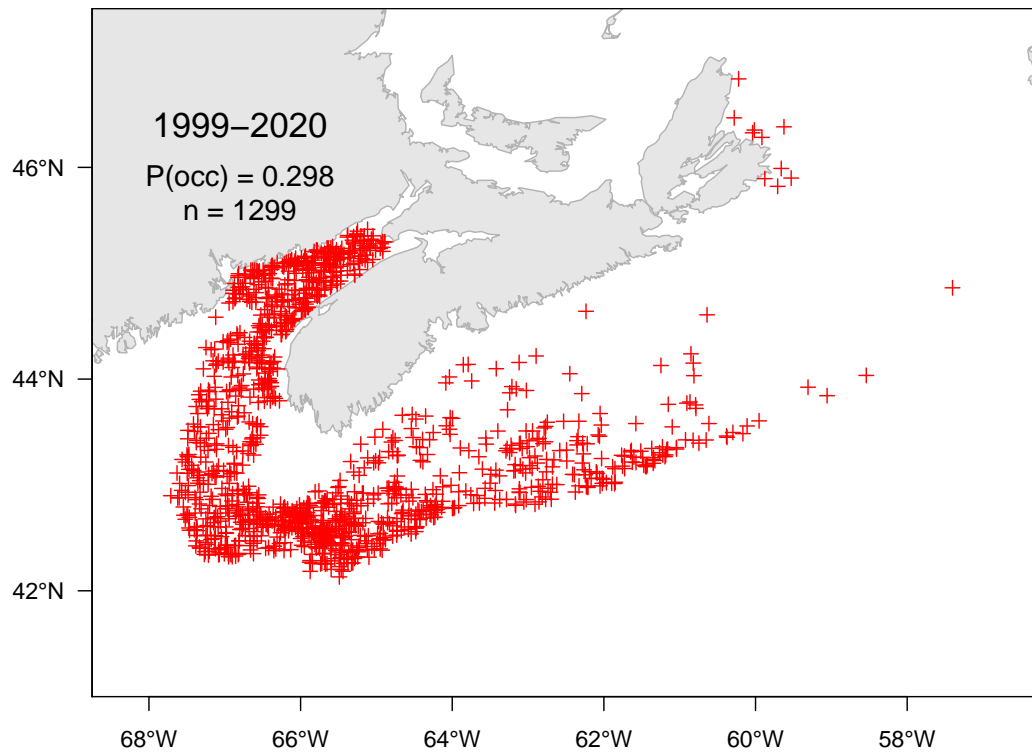
Figure 7.8A. Catch distribution for American lobster.

7.9   Sea lamprey (Lamproie marine) - species code 240 (category LR)

Scientific name: Petromyzon marinus

Figure 7.9A. Catch distribution for Sea lamprey.
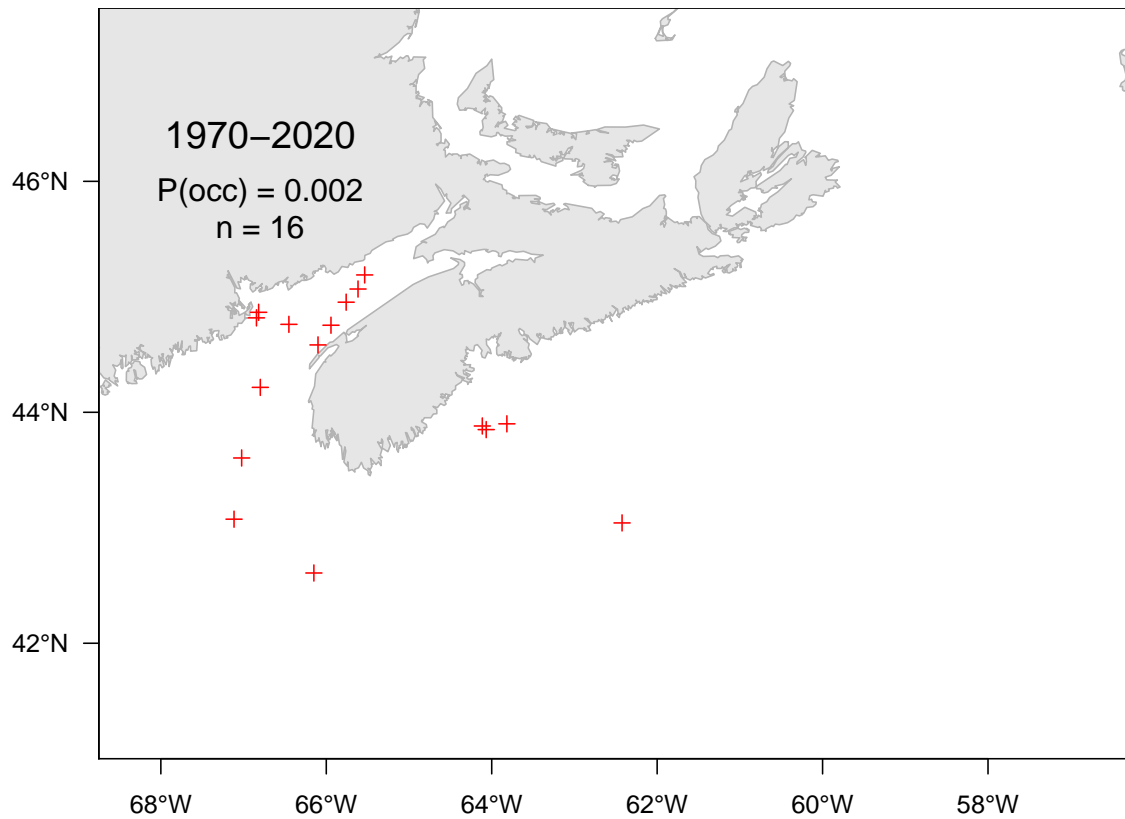
7.10   Atlantic tomcod (Poulamon atlantique) - species code 17 (category LR)

Scientific name: Microgadus tomcod
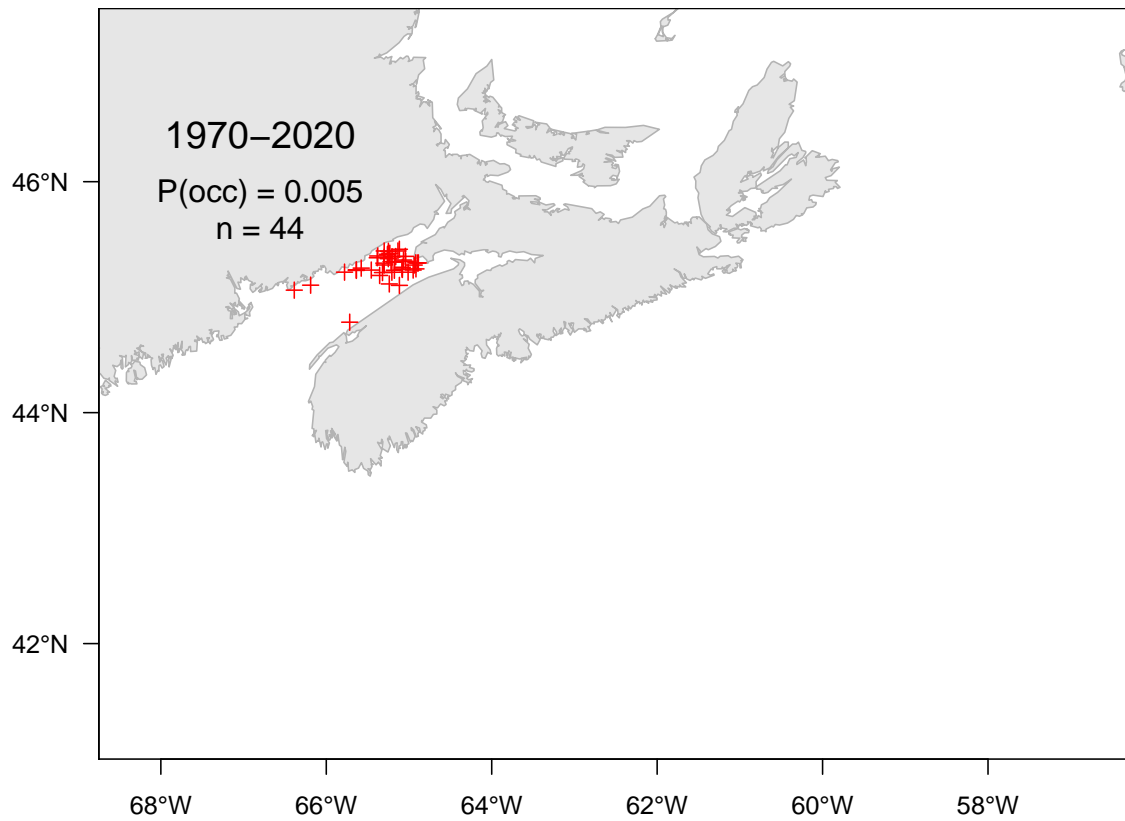
Figure 7.10A. Catch distribution for Atlantic tomcod.

7.11 Offshore silver hake (Merlu argenté du large) - species code 19 (category LR)

Scientific name: Merluccius albidus
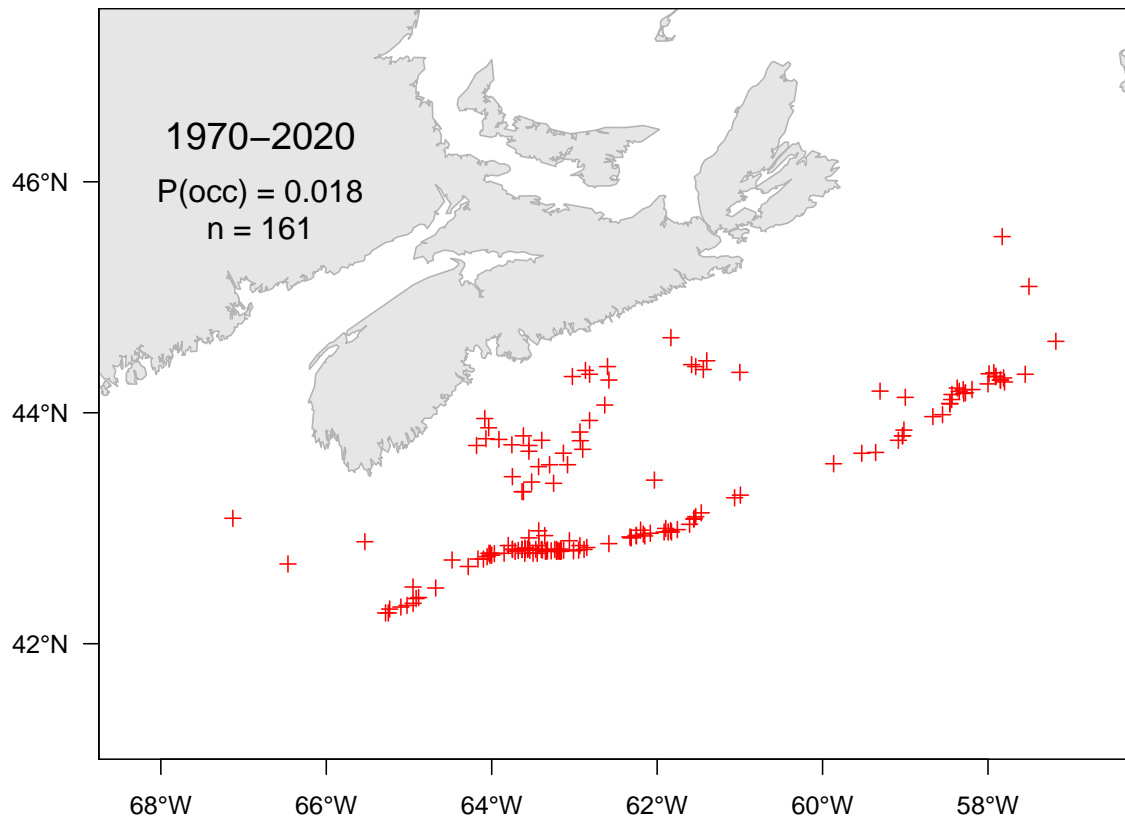
Figure 7.11A. Catch distribution for Offshore silver hake.

7.12 Spotted wolffish (Loup tacheté) - species code 51 (category LR)

Scientific name: Anarhichas minor

1970–2020

P(occ) = 0.002

n = 20
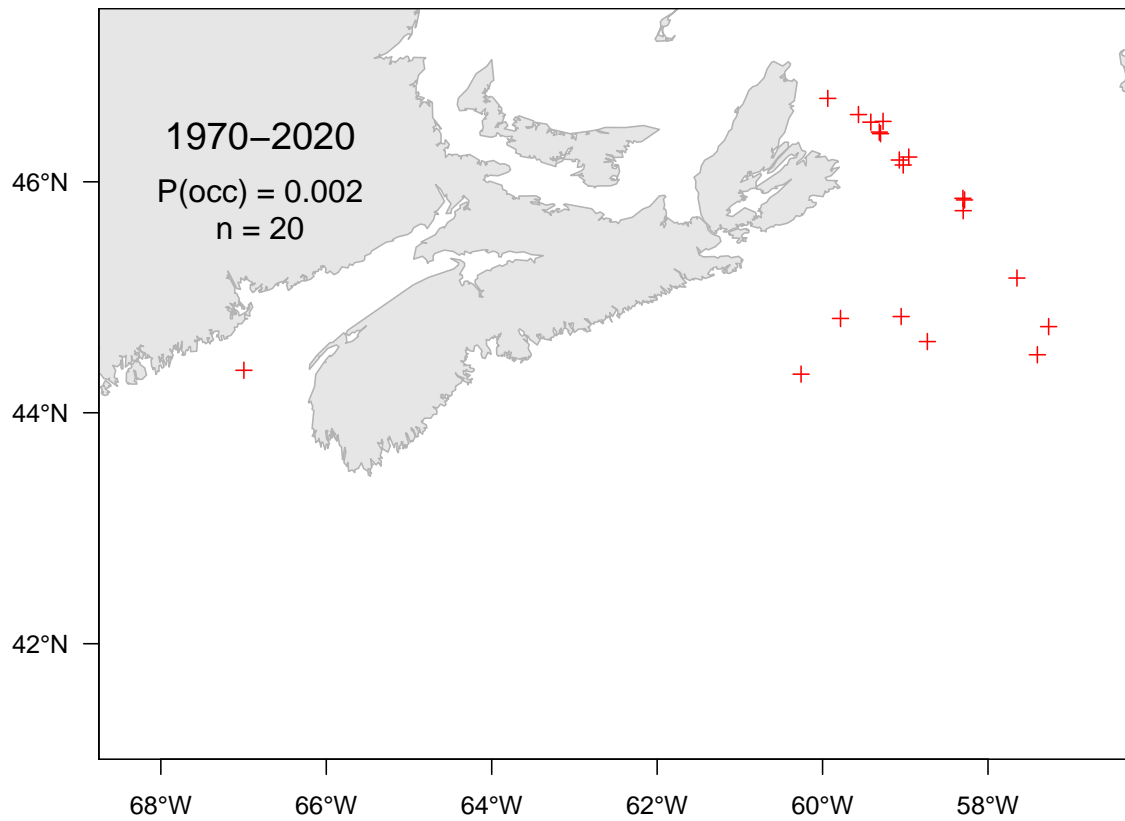
Figure 7.12A. Catch distribution for Spotted wolffish.

7.13 Northern wolffish (Loup à tête large) - species code 52 (category LR)

Scientific name: Anarhichas denticulatus
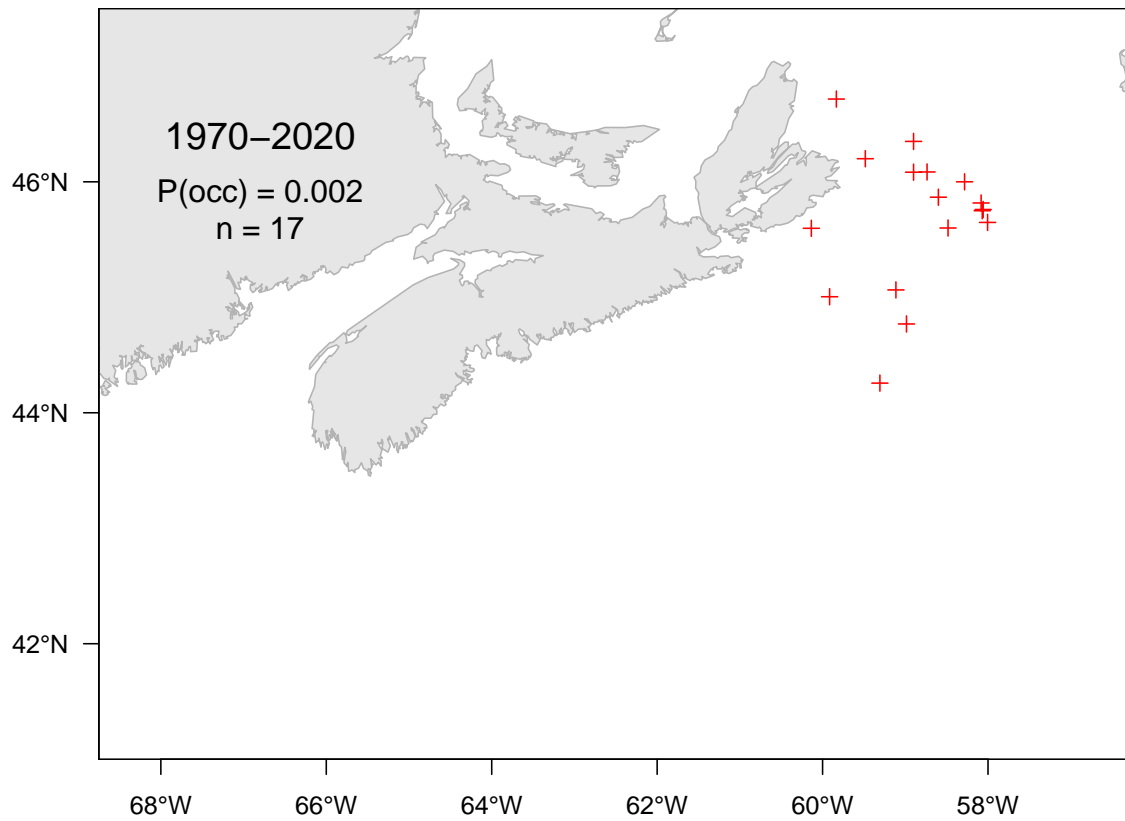
Figure 7.13A. Catch distribution for Northern wolffish.

7.14   Rainbow smelt (Éperlan arc-en-ciel) - species code 63 (category LR)

Scientific name: Osmerus mordax
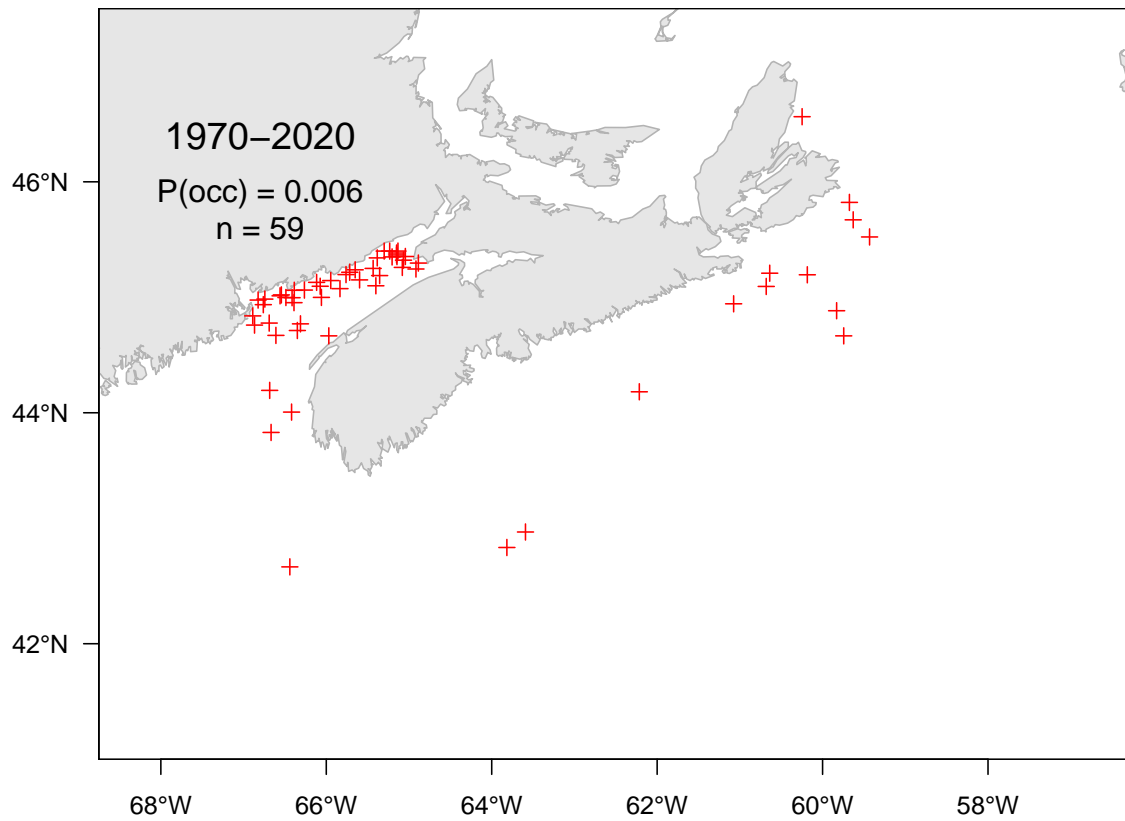
Figure 7.14A. Catch distribution for Rainbow smelt.

7.15   Cunner (Tanche-tautogue) - species code 122 (category LR)

Scientific name: Tautogolabrus adspersus
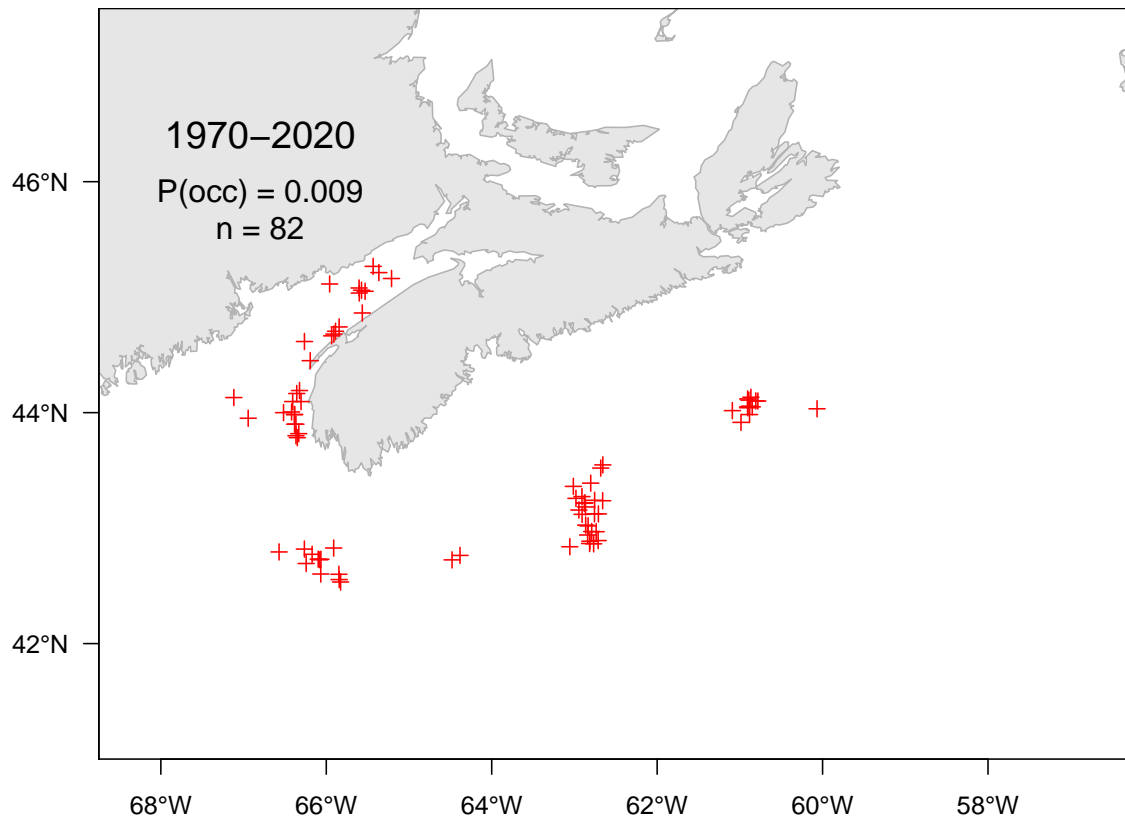
Figure 7.15A. Catch distribution for Cunner.

7.16 Fourspot flounder (Cardeau à quatre ocelles) - species code 142 (category LR)

Scientific name: Hippoglossina oblonga
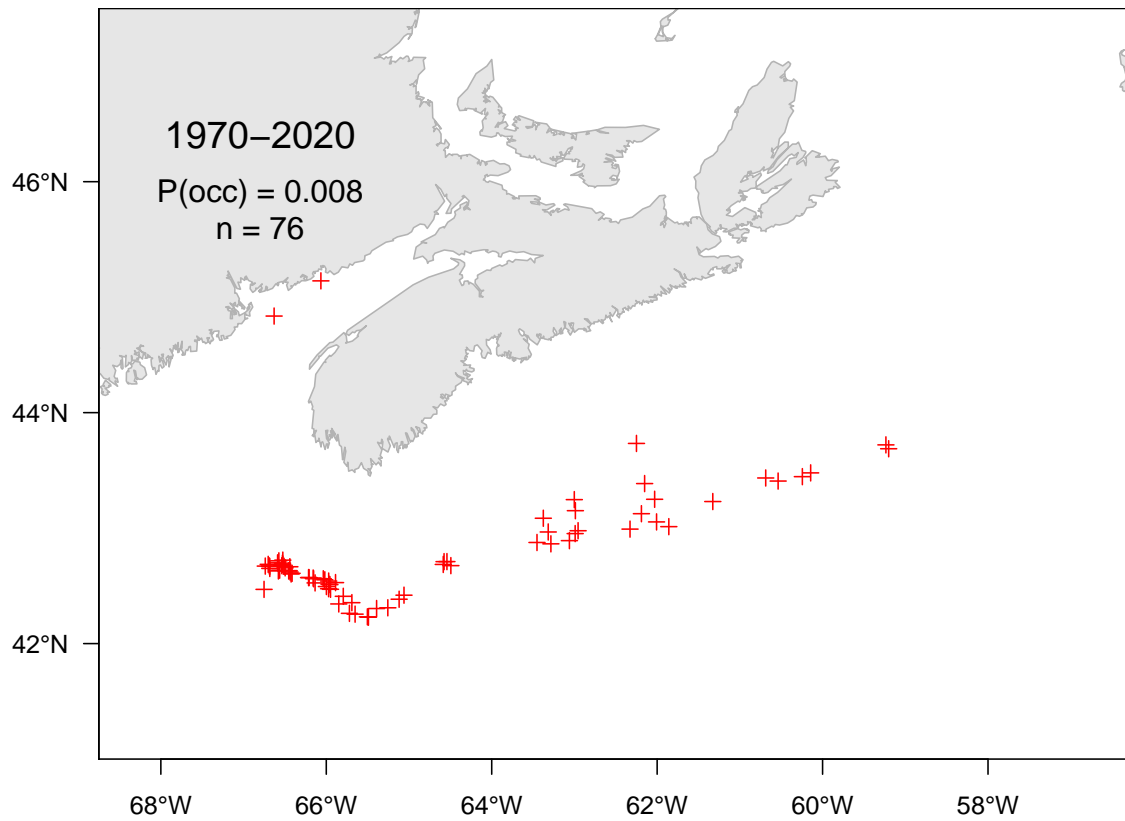
Figure 7.16A. Catch distribution for Fourspot flounder.

7.17 Windowpane flounder (Turbot de sable) - species code 143 (category LR)

Scientific name: Scophthalmus aquosus

1970–2020

P(occ) = 0.013

n = 115
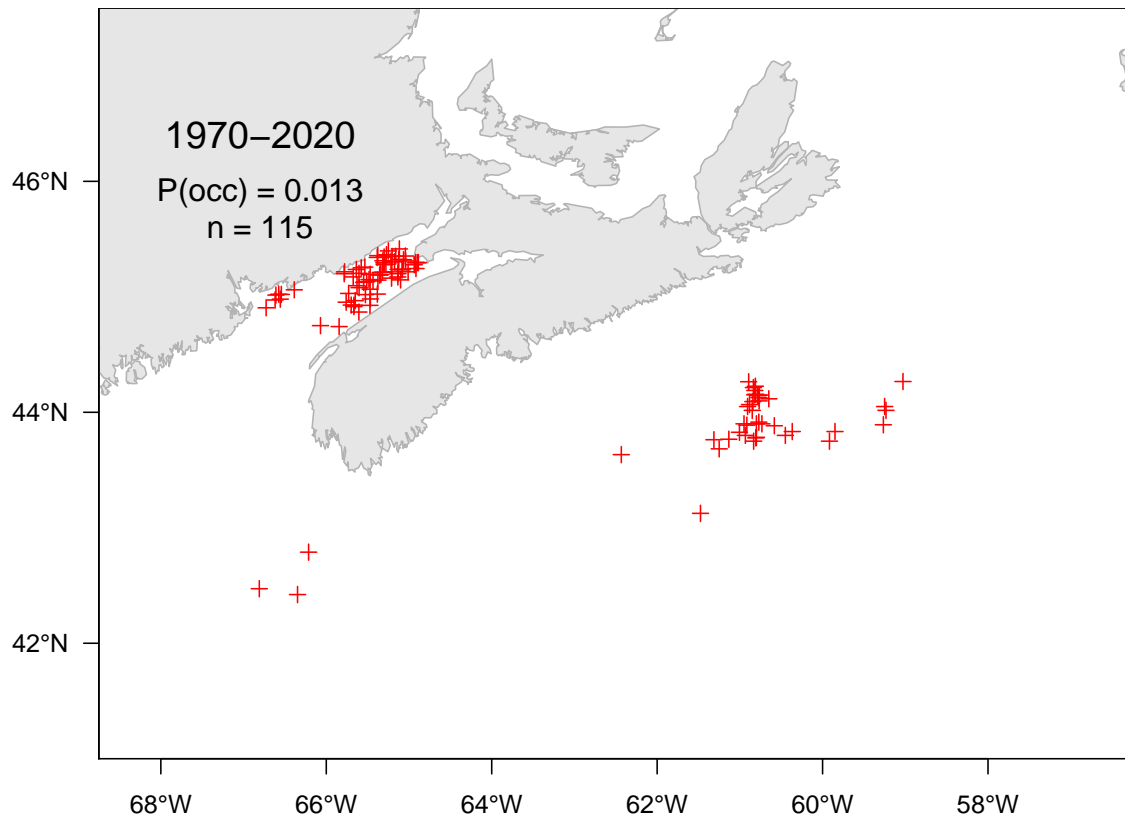
Figure 7.17A. Catch distribution for Windowpane flounder.

7.18   Longnose greeneye (Oeil-vert à long nez) - species code 149 (category LR)

Scientific name: Parasudis truculenta
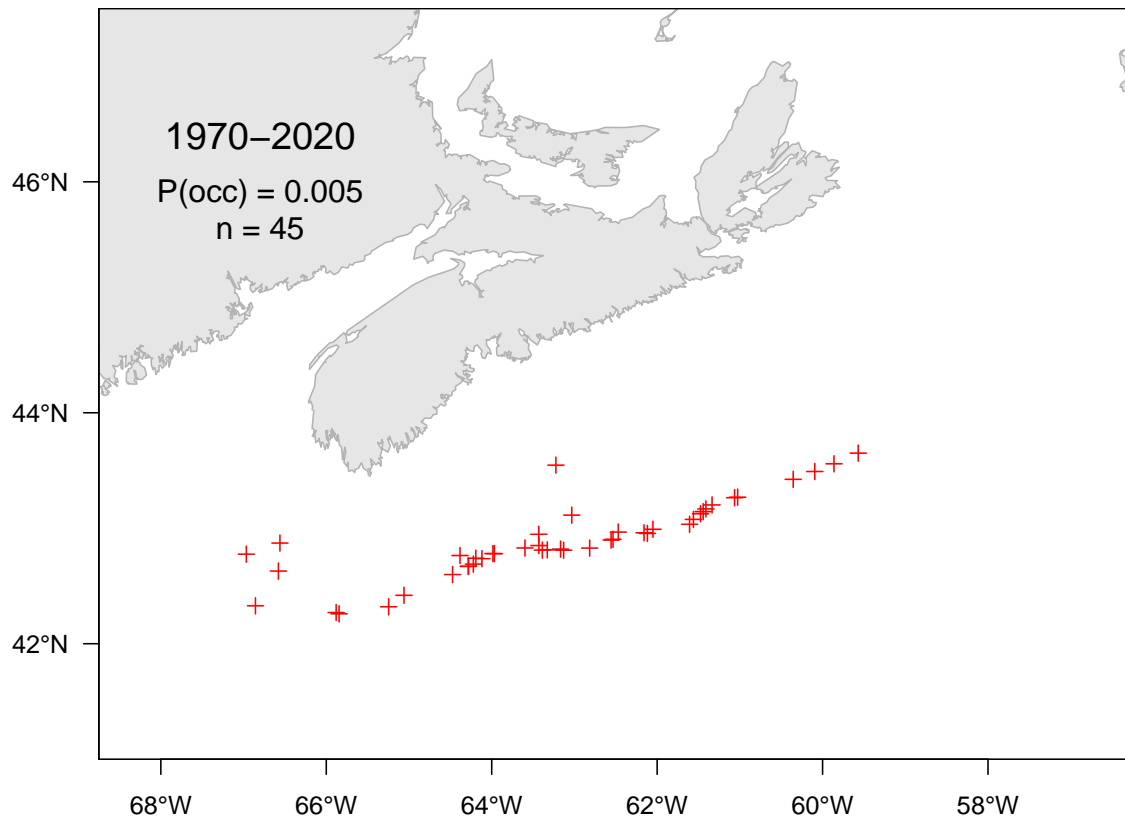
Figure 7.18A. Catch distribution for Longnose greeneye.

7.19   Lanternfishes (Poissons-lanternes) - species code 150 (category LR)

Scientific name: Myctophidae
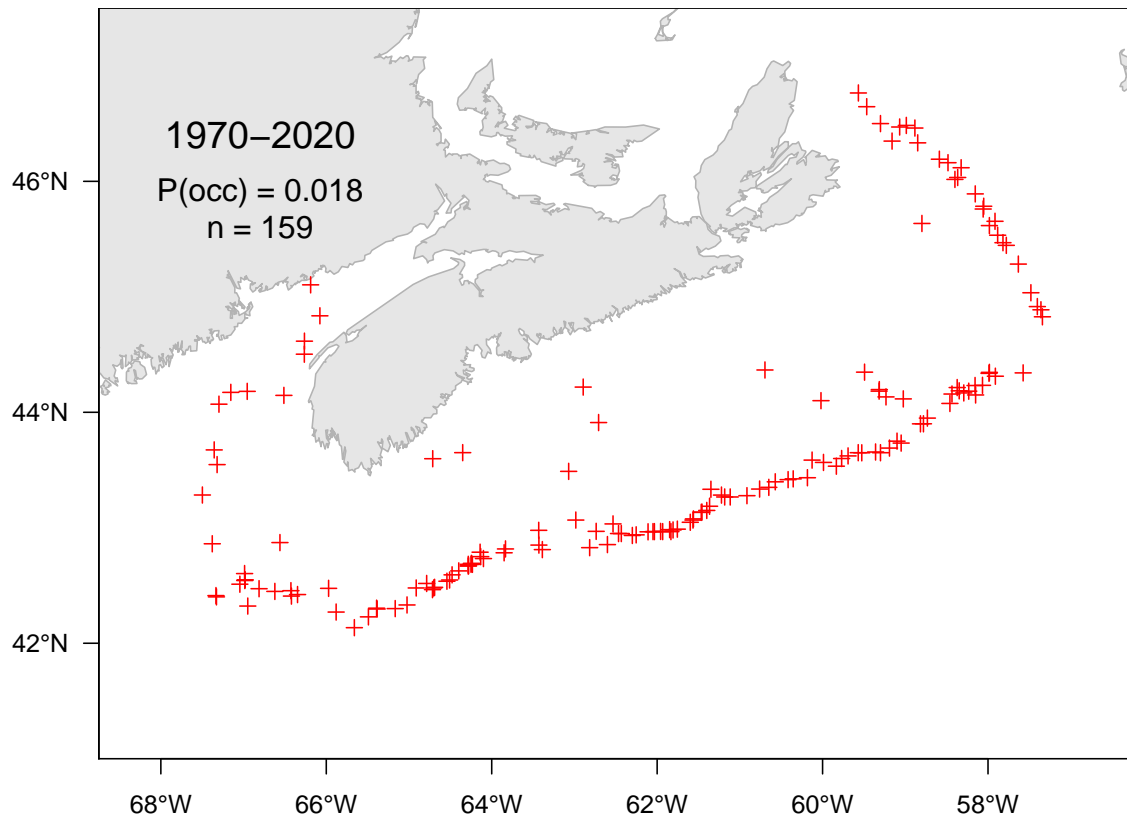
Figure 7.19A. Catch distribution for Lanternfishes.

7.20   Shortnose greeneye (Éperlan du large) - species code 156 (category LR)

Scientific name: Chlorophthalmus agassizi
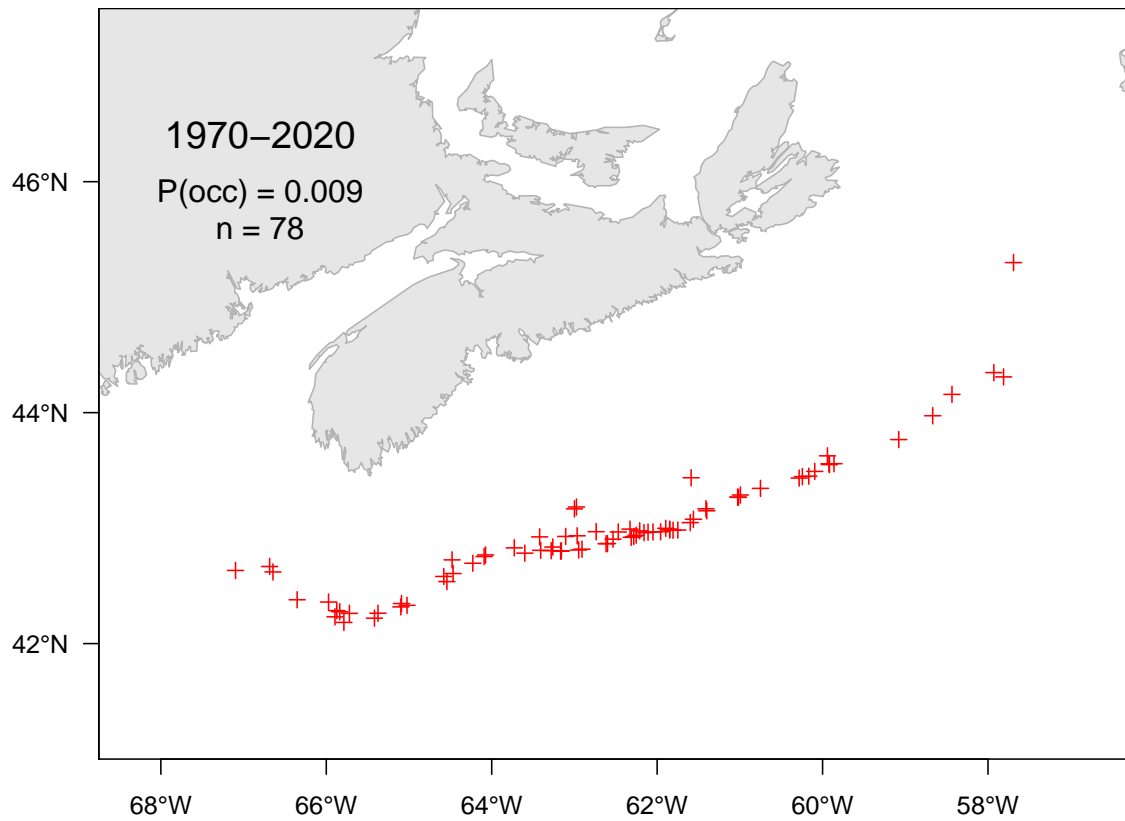
Figure 7.20A. Catch distribution for Shortnose greeneye.

7.21 Silvery lightfish (Brossé améthyste) - species code 158 (category LR)

Scientific name: Maurolicus muelleri
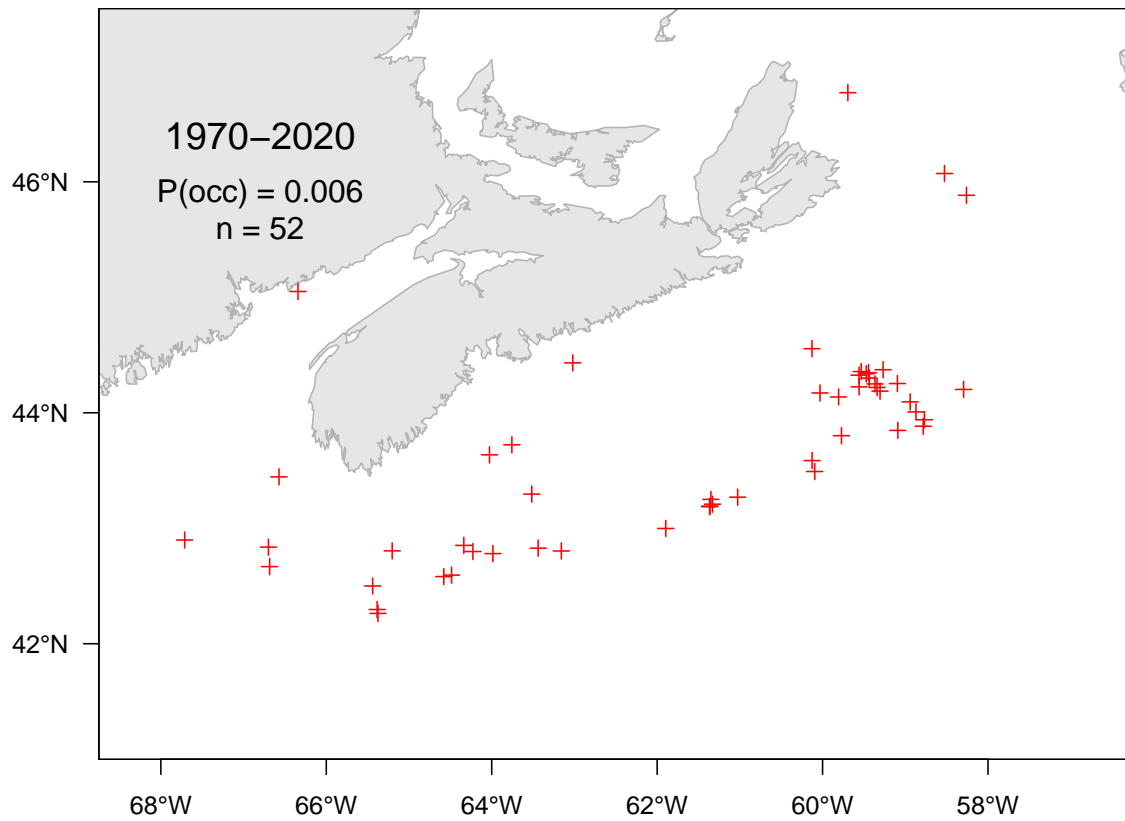
Figure 7.21A. Catch distribution for Silvery lightfish.

7.22 Boa dragonfish (Dragon-boa) - species code 159 (category LR)

Scientific name: Stomias boa
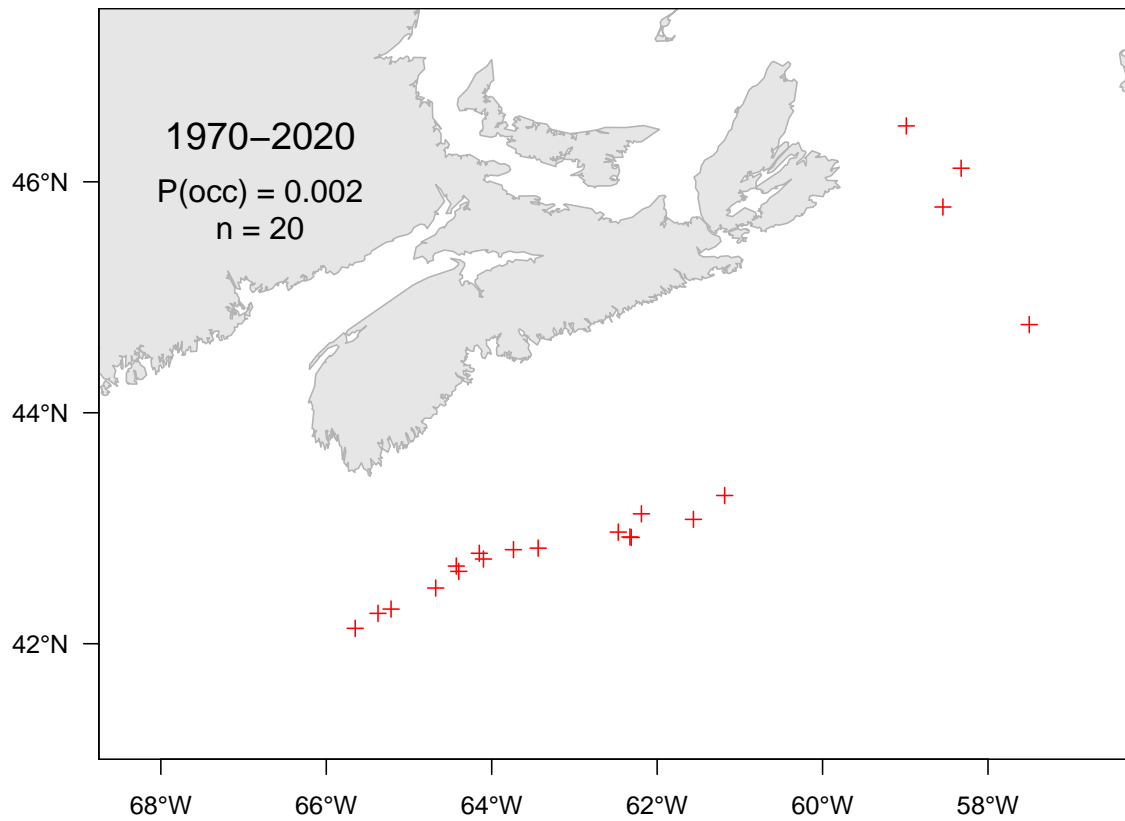
Figure 7.22A. Catch distribution for Boa dragonfish.

7.23 Shorthorn sculpin (Chaboisseau à épines courtes) - species code 301 (category LR)

Scientific name: Myoxocephalus scorpius
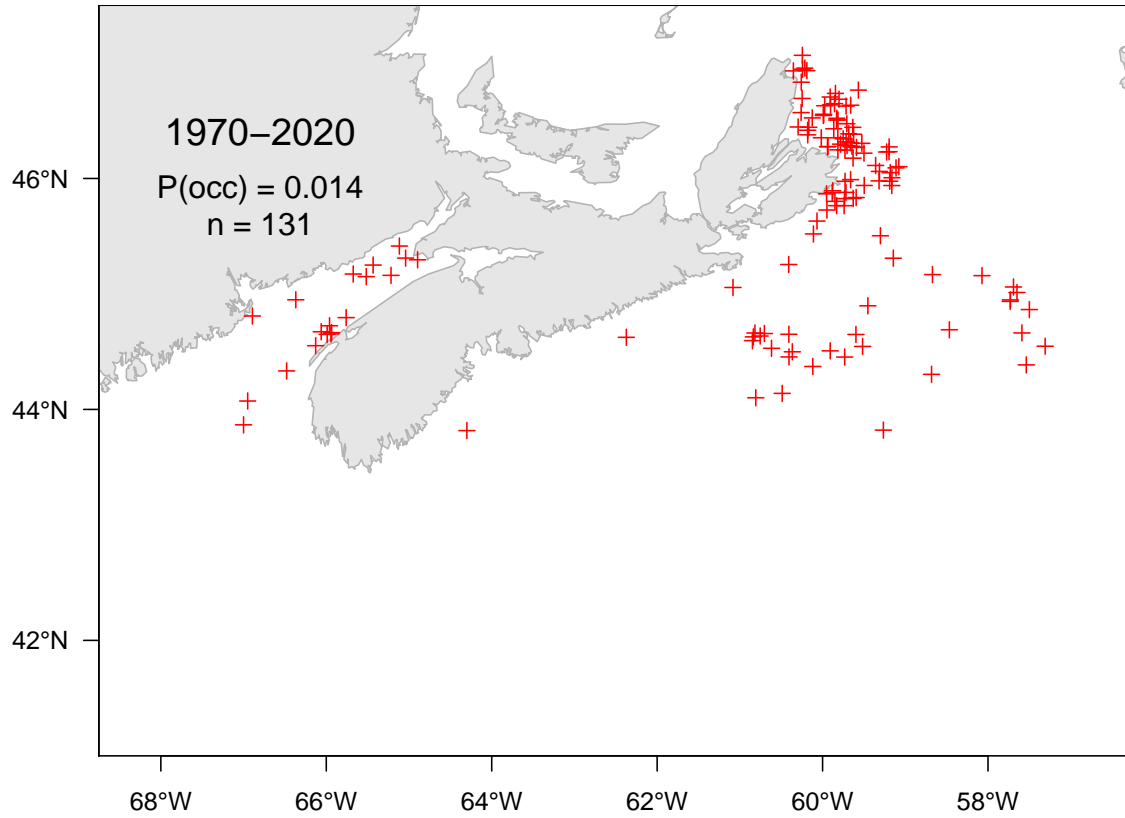
Figure 7.23A. Catch distribution for Shorthorn sculpin.

7.24   Grubby (Chaboisseau bronzé) - species code 303 (category LR)

Scientific name: Myoxocephalus aenaeus

1970–2020

P(occ) = 0.004

n = 40
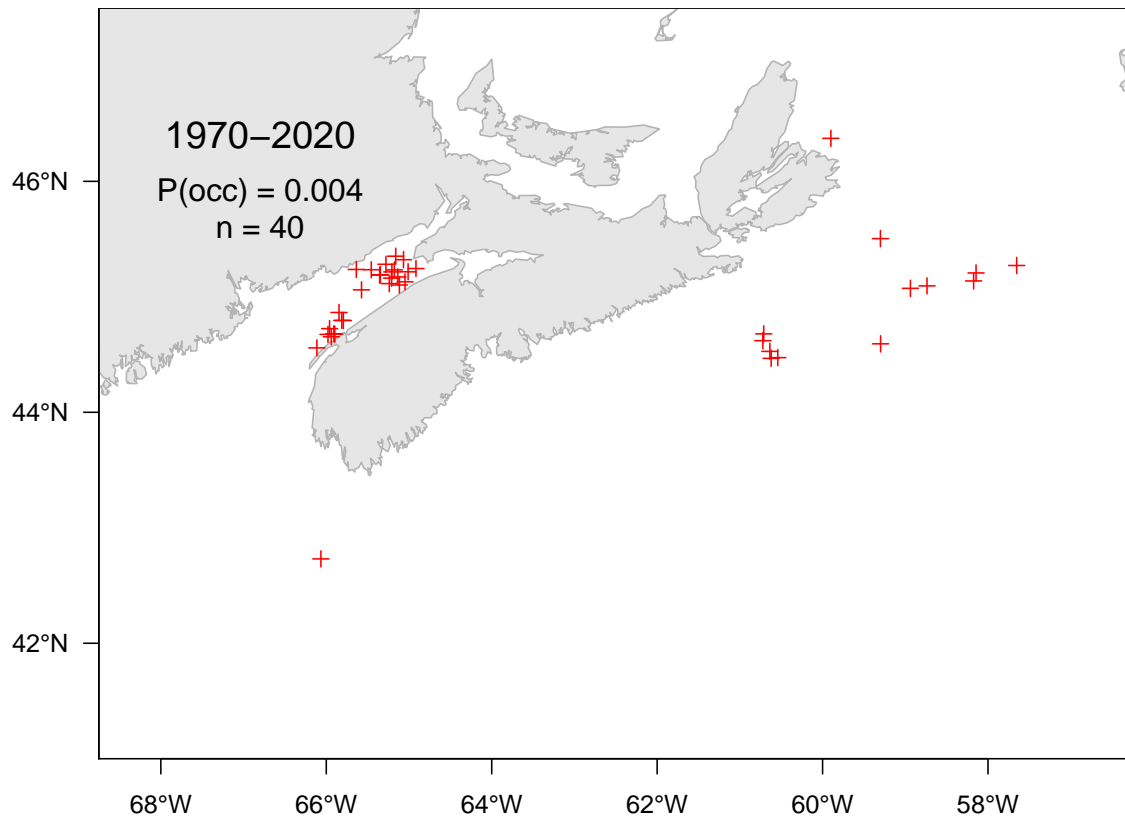
Figure 7.24A. Catch distribution for Grubby.

7.25 Polar sculpin (Cotte polaire) - species code 307 (category LR)

Scientific name: Cottunculus microps

1970–2020

P(occ) = 0.003

n = 29
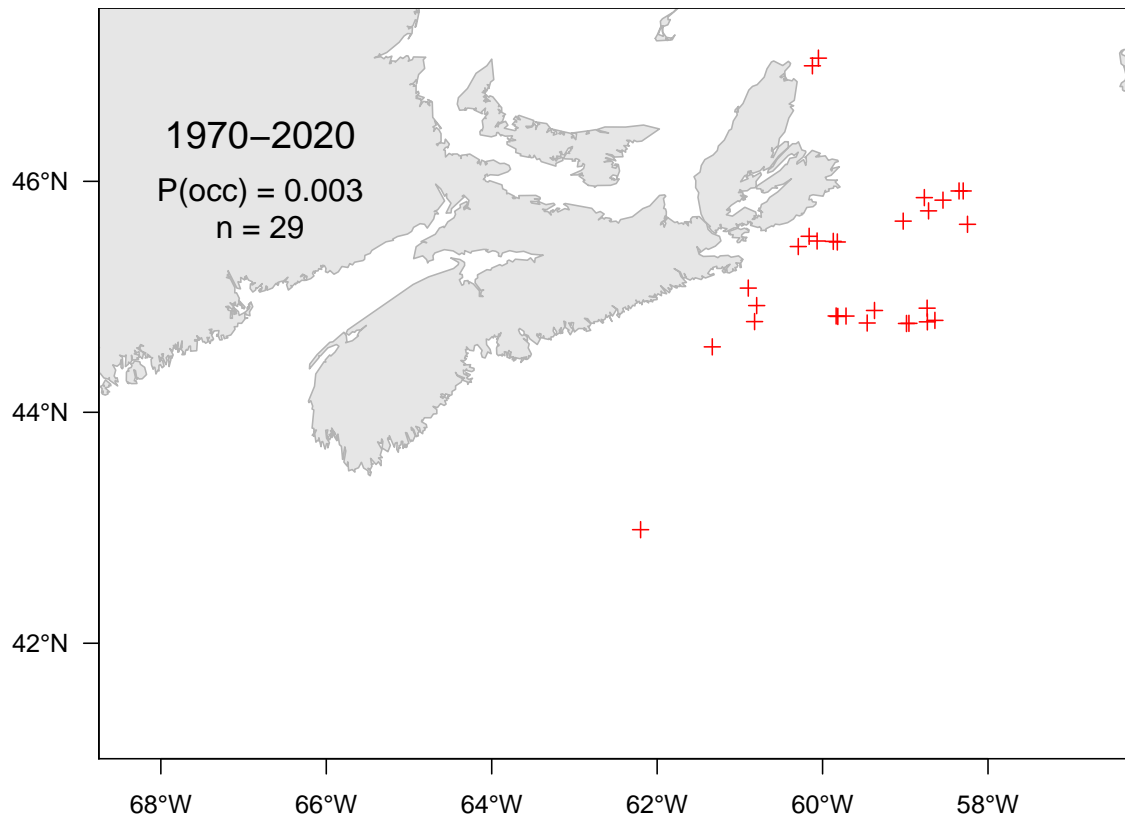
Figure 7.25A. Catch distribution for Polar sculpin.

7.26 Spatulate sculpin (Icèle spatulée) - species code 314 (category LR)

Scientific name: Icelus spatula
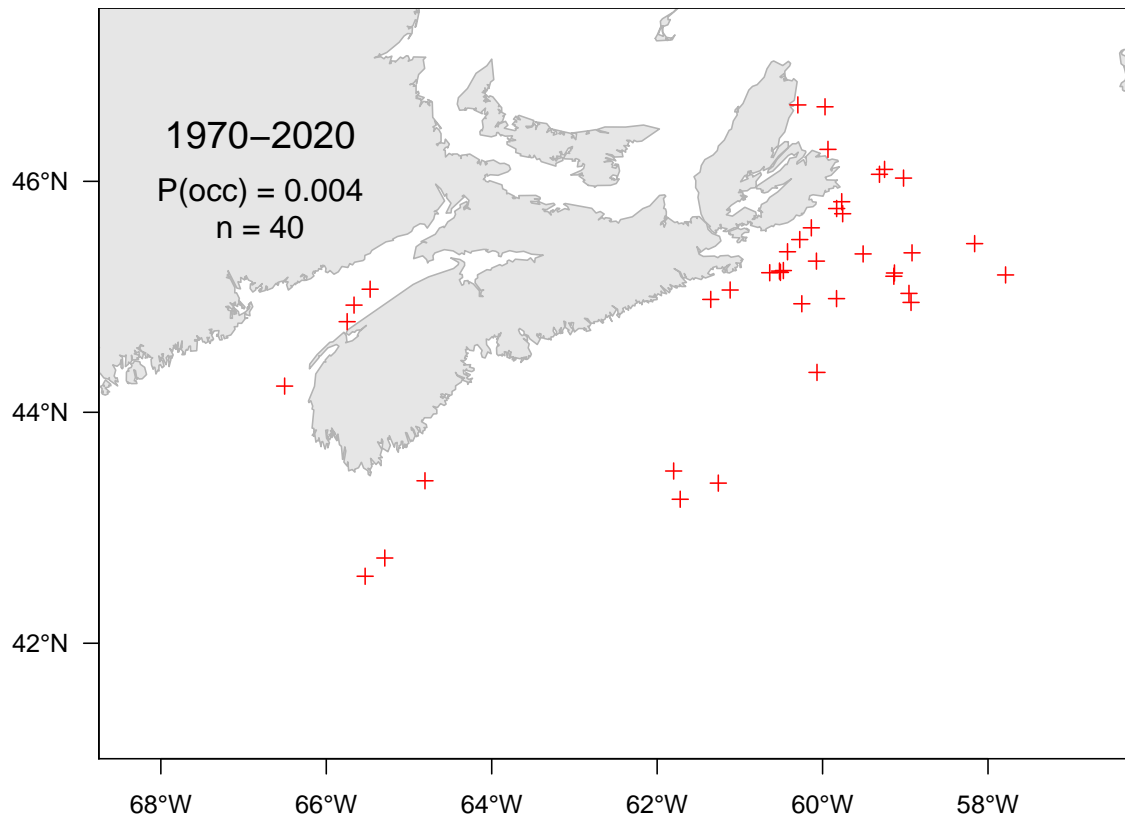
Figure 7.26A. Catch distribution for Spatulate sculpin.

7.27 Arctic alligatorfish (Poisson-alligator arctique) - species code 341 (category LR)

Scientific name: Ulcina olrikii
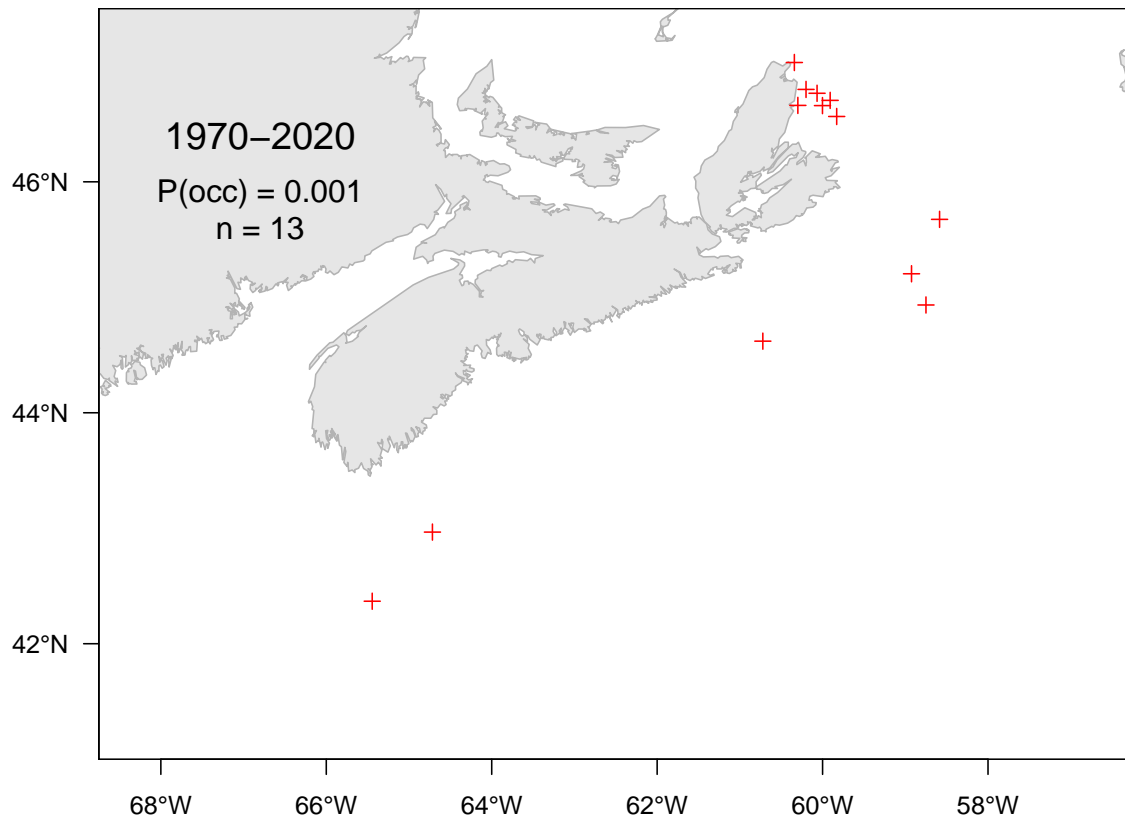
Figure 7.27A. Catch distribution for Arctic alligatorfish.

7.28 Alligatorfishes (Poissons-alligator) - species code 351 (category LR)

Scientific name: Agonidae
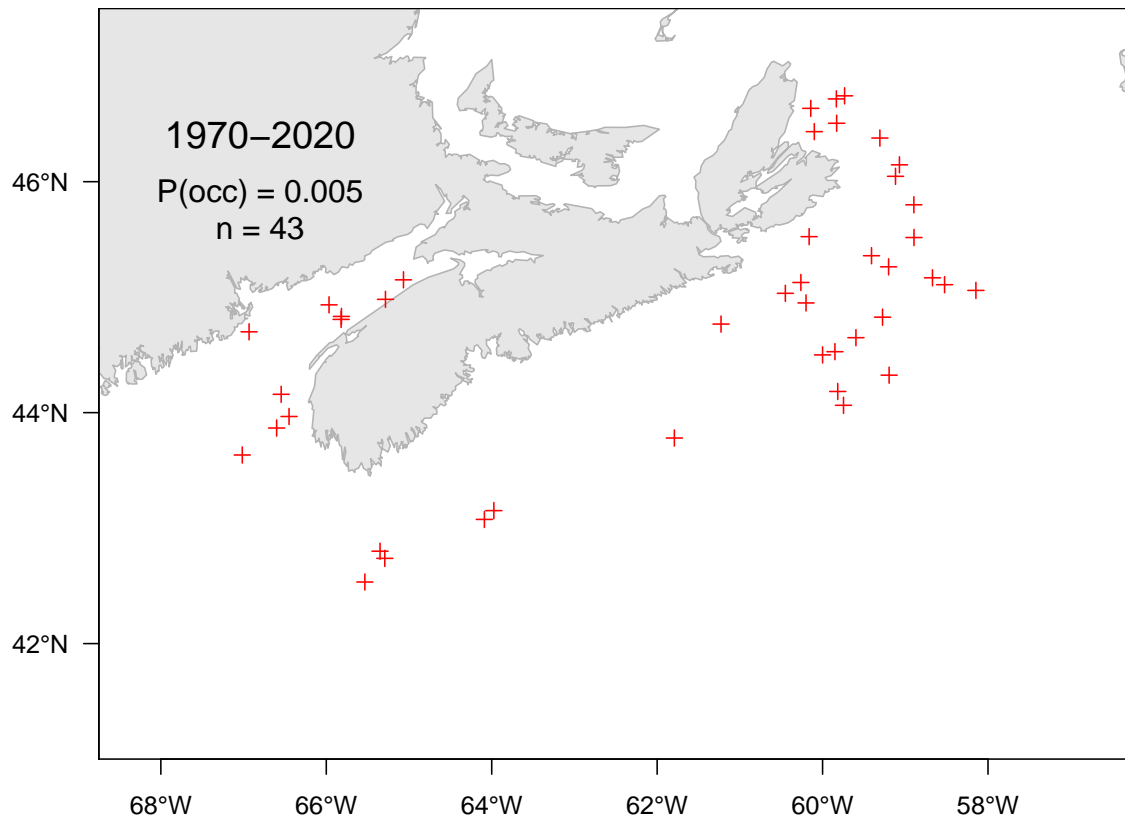
Figure 7.28A. Catch distribution for Alligatorfishes.

7.29   Roughnose grenadier (Grenadier-scie) - species code 412 (category LR)

Scientific name: Trachyrincus murrayi
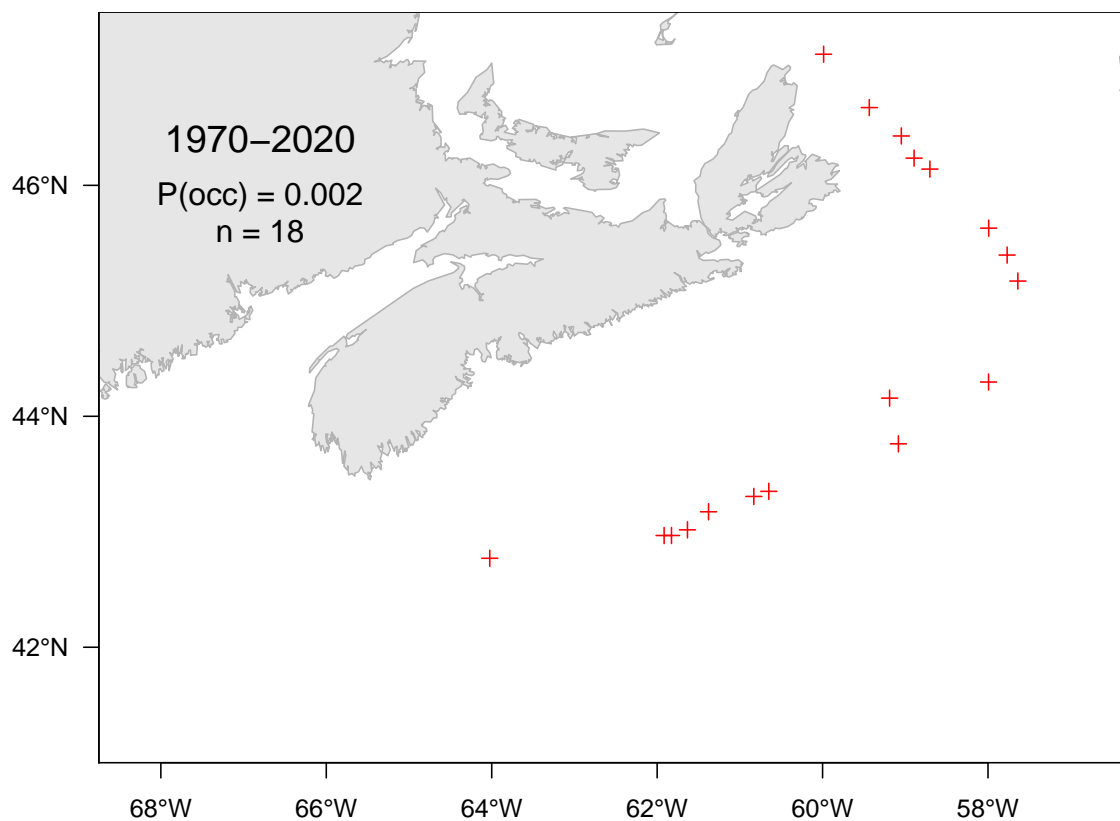
Figure 7.29A. Catch distribution for Roughnose grenadier.

7.30   Roundnose grenadier (Grenadier de roche) - species code 414 (category LR)

Scientific name: Coryphaenoides rupestris
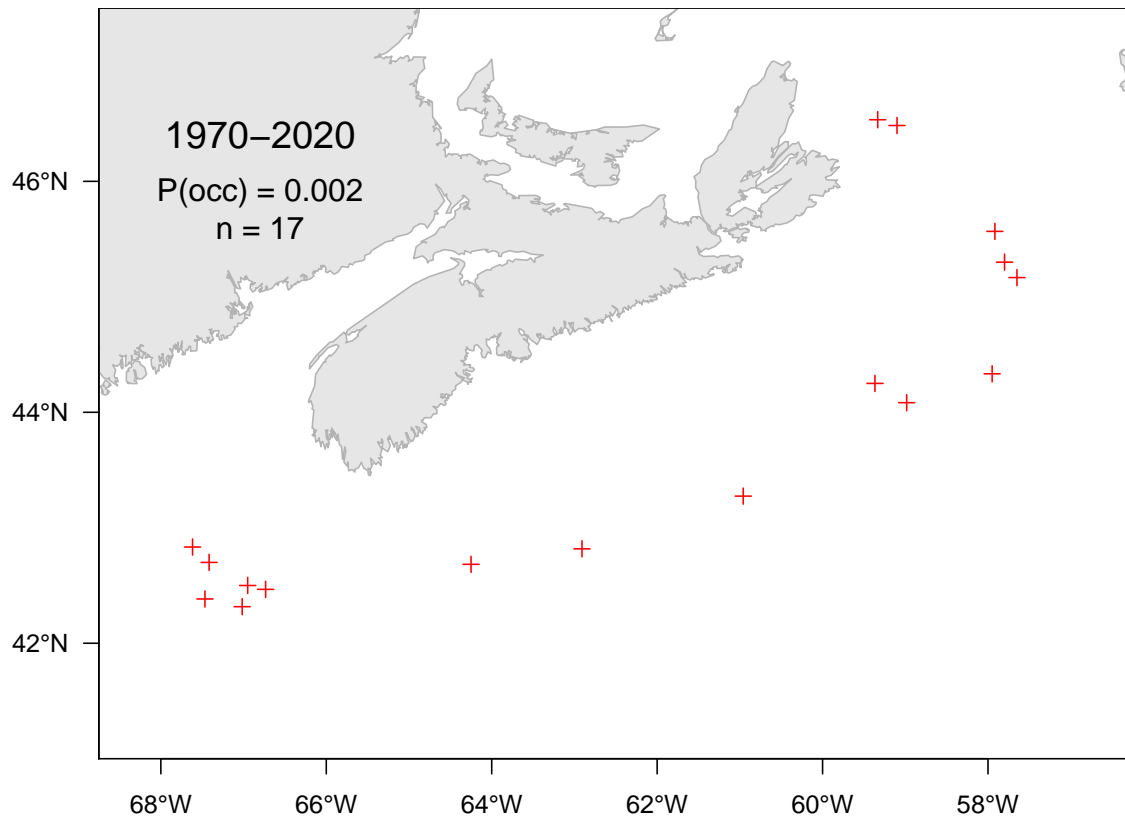
Figure 7.30A. Catch distribution for Roundnose grenadier.

7.31 Atlantic seasnail (Limace atlantique) - species code 503 (category LR)

Scientific name: Liparis atlanticus

1970–2020

P(occ) = 0.004

n = 34
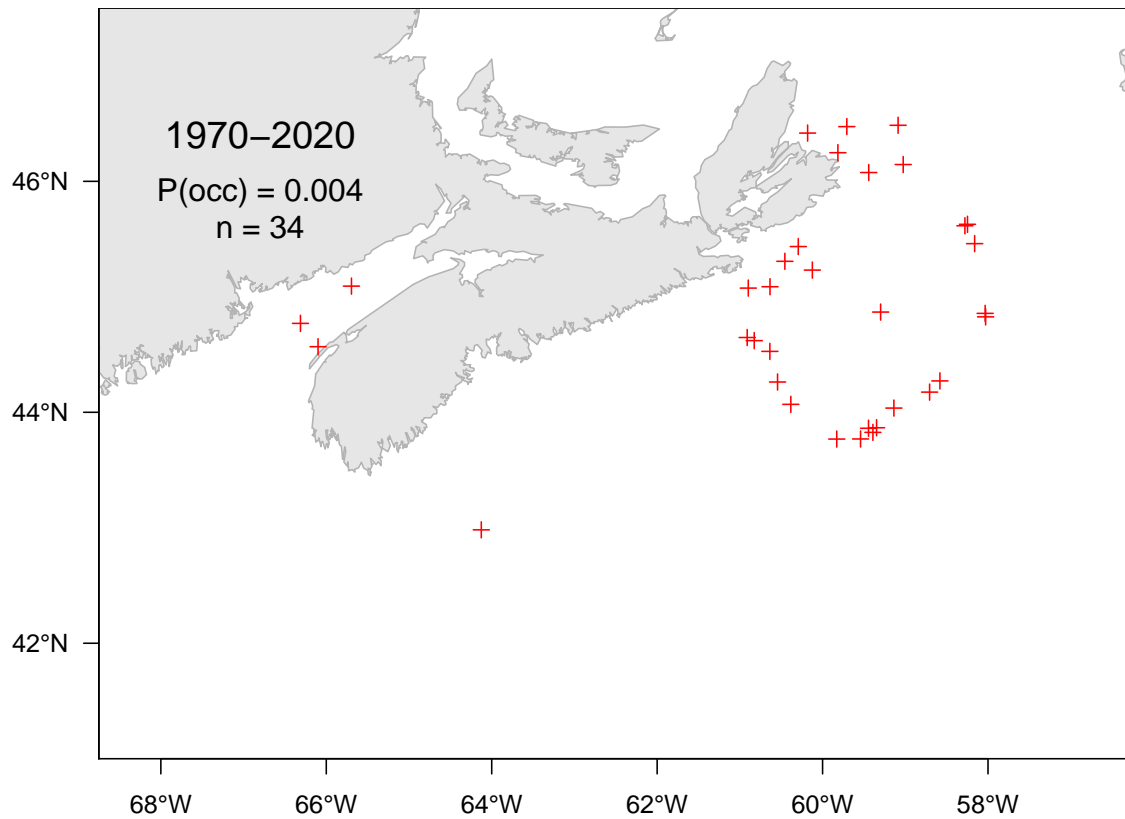
Figure 7.31A. Catch distribution for Atlantic seasnail.

7.32 Gelatinous snailfish (Limace gélatineuse) - species code 505 (category LR)

Scientific name: Liparis fabricii
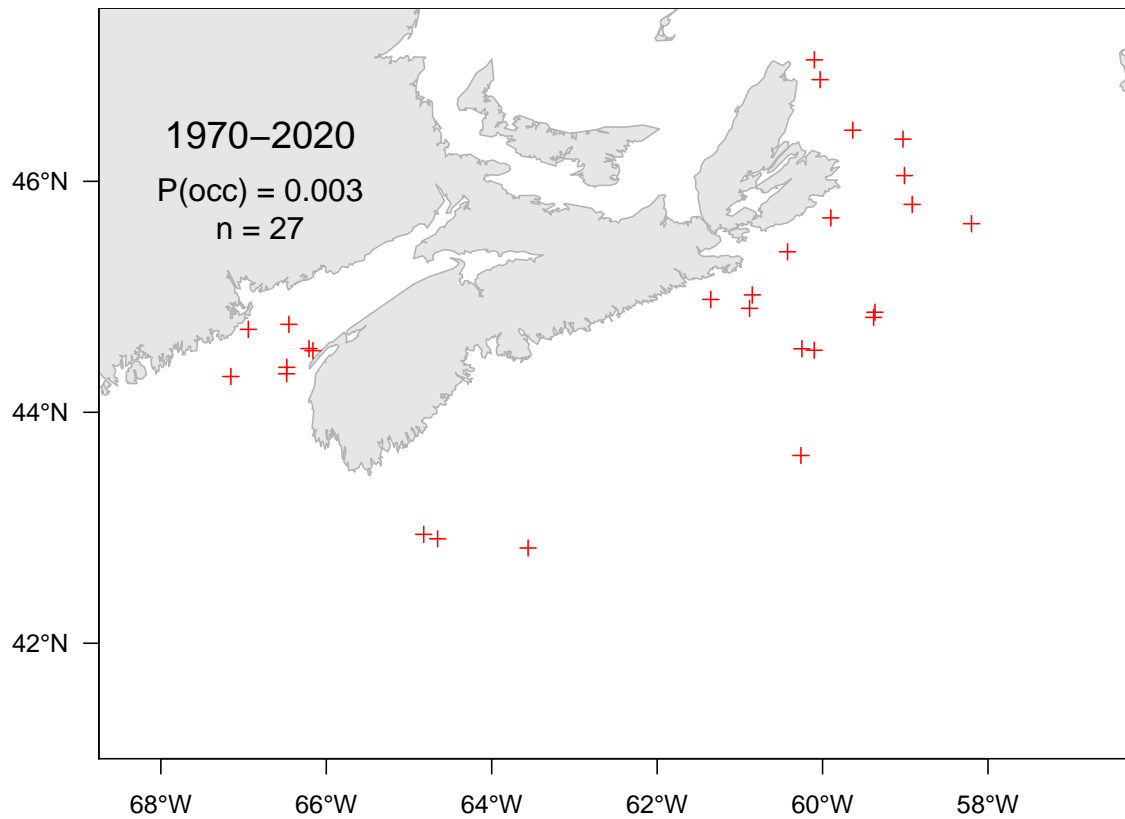
Figure 7.32A. Catch distribution for Gelatinous snailfish.

7.33 Variegated snailfish (Limace marbée) - species code 512 (category LR)

Scientific name: Liparis gibbus

1970–2020

P(occ) = 0.004

n = 40
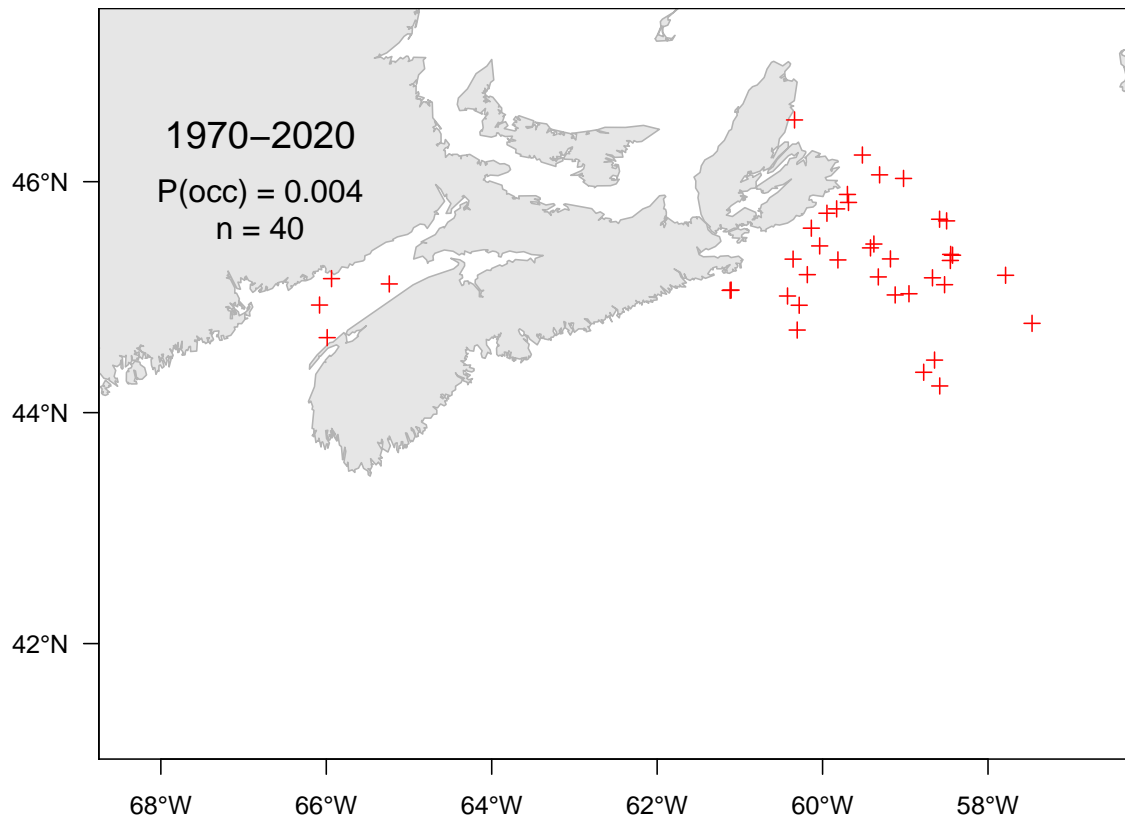
Figure 7.33A. Catch distribution for Variegated snailfish.

7.34 Sea tadpole (Petite limace de mer) - species code 520 (category LR)

Scientific name: Careproctus reinhardti
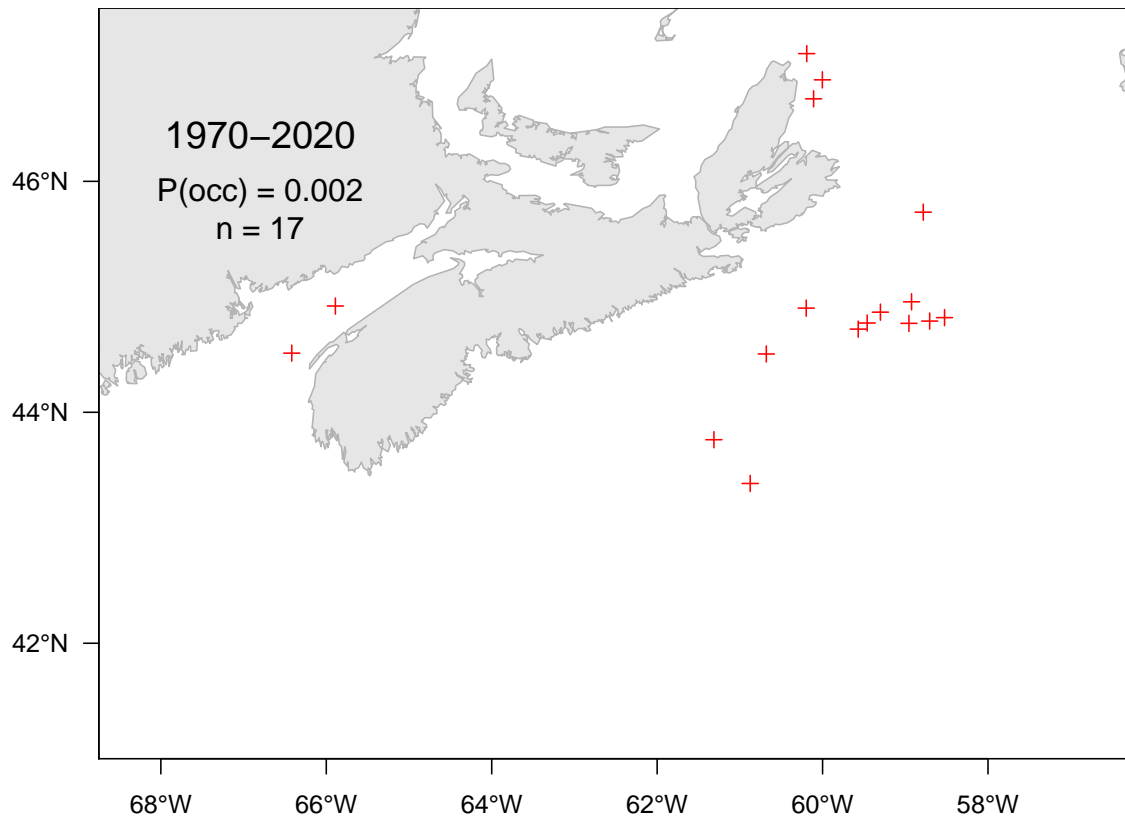
Figure 7.34A. Catch distribution for Sea tadpole.

7.35 Wolf eelpout (Lycode à tête longue) - species code 603 (category LR)

Scientific name: Lycenchelys verrillii
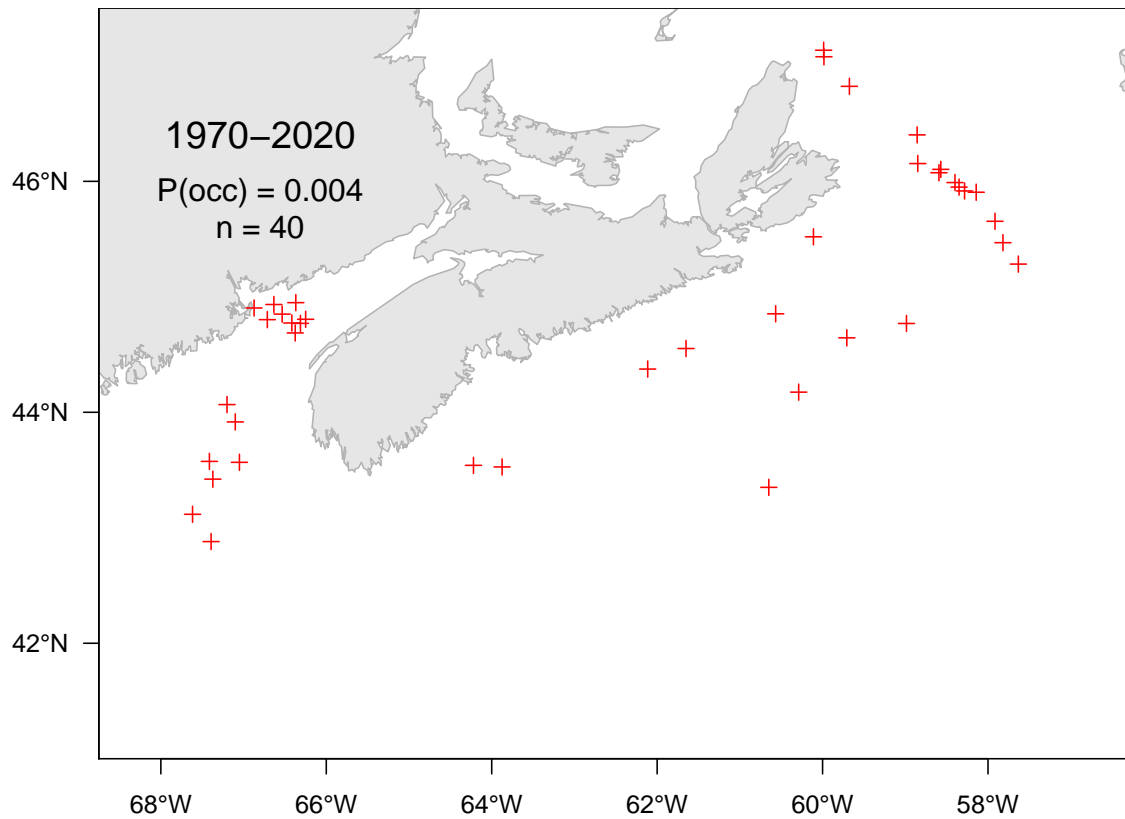
Figure 7.35A. Catch distribution for Wolf eelpout.

7.36 Slender snipe eel (Avocette ruban) - species code 604 (category LR)

Scientific name: Nemichthys scolopaceus
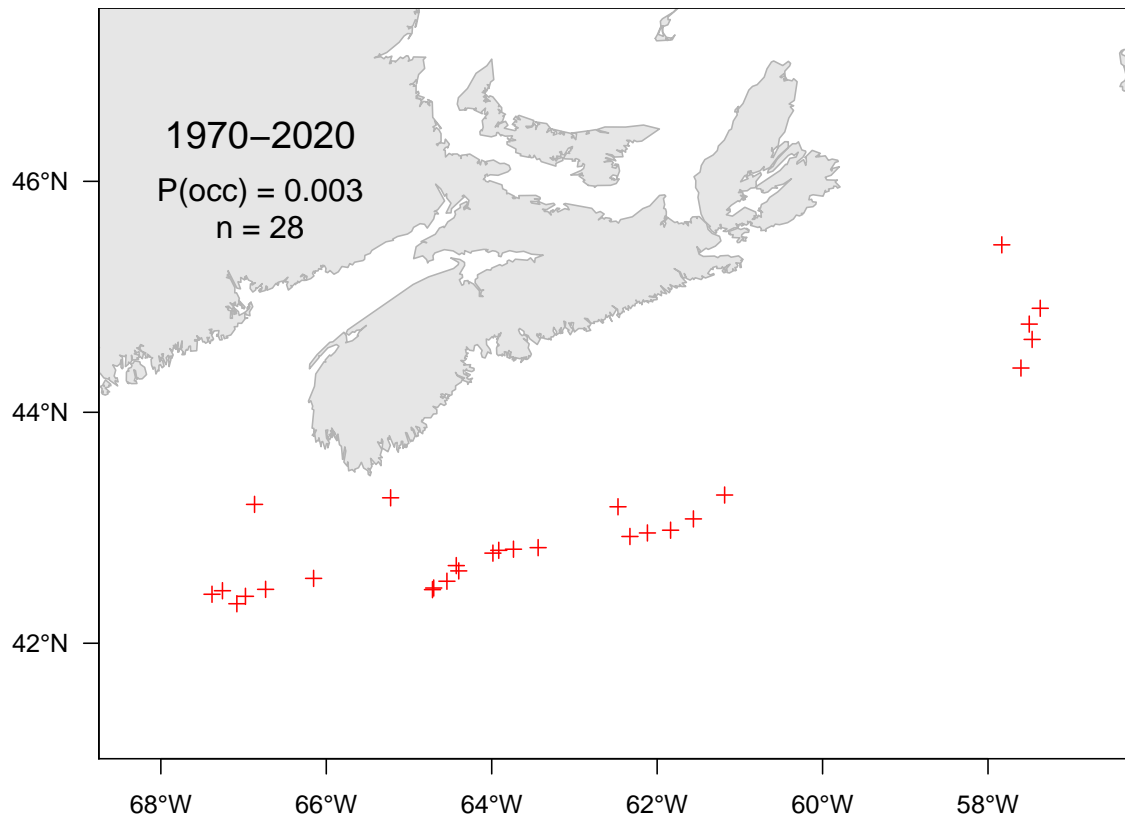
Figure 7.36A. Catch distribution for Slender snipe eel.

7.37 Newfoundland eelpout (Lycode du Labrador) - species code 619 (category LR)

Scientific name: Lycodes terraenovae
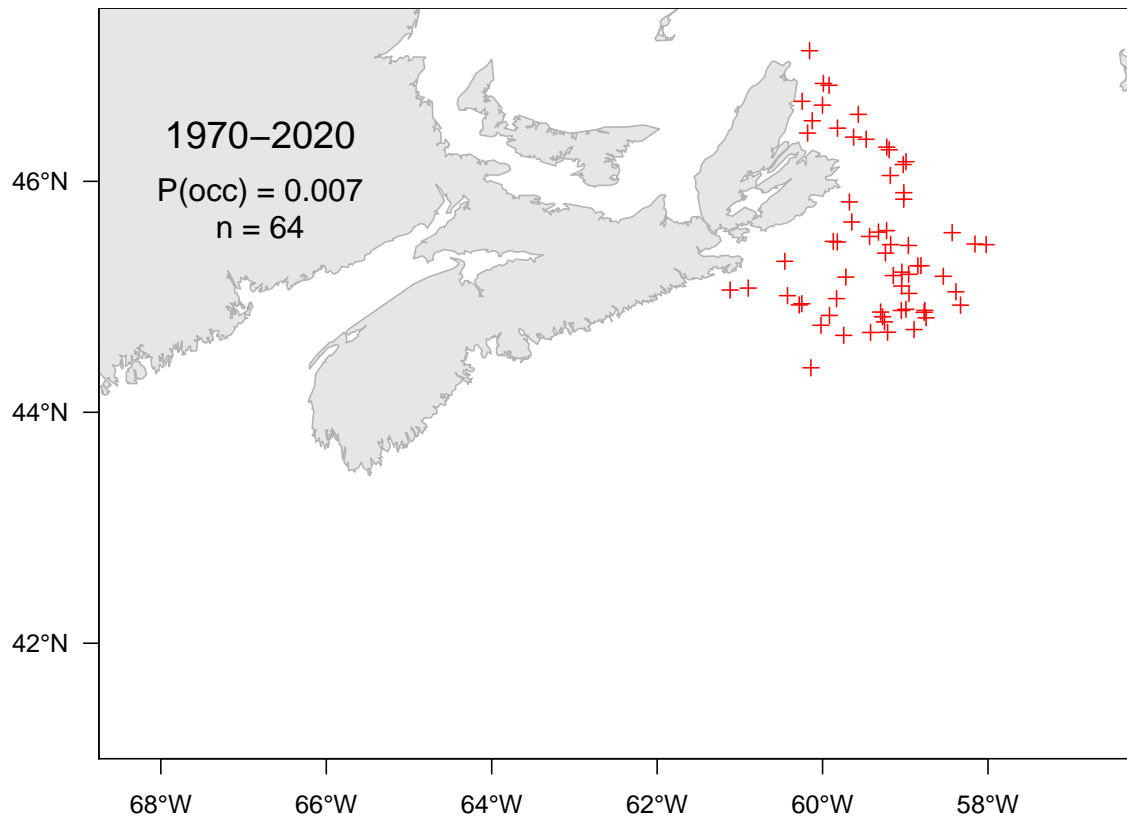
Figure 7.37A. Catch distribution for Newfoundland eelpout.

7.38 Newfoundland eelpout (Lycode du Labrador) - species code 620 (category LR)

Scientific name: Lycodes lavalaei
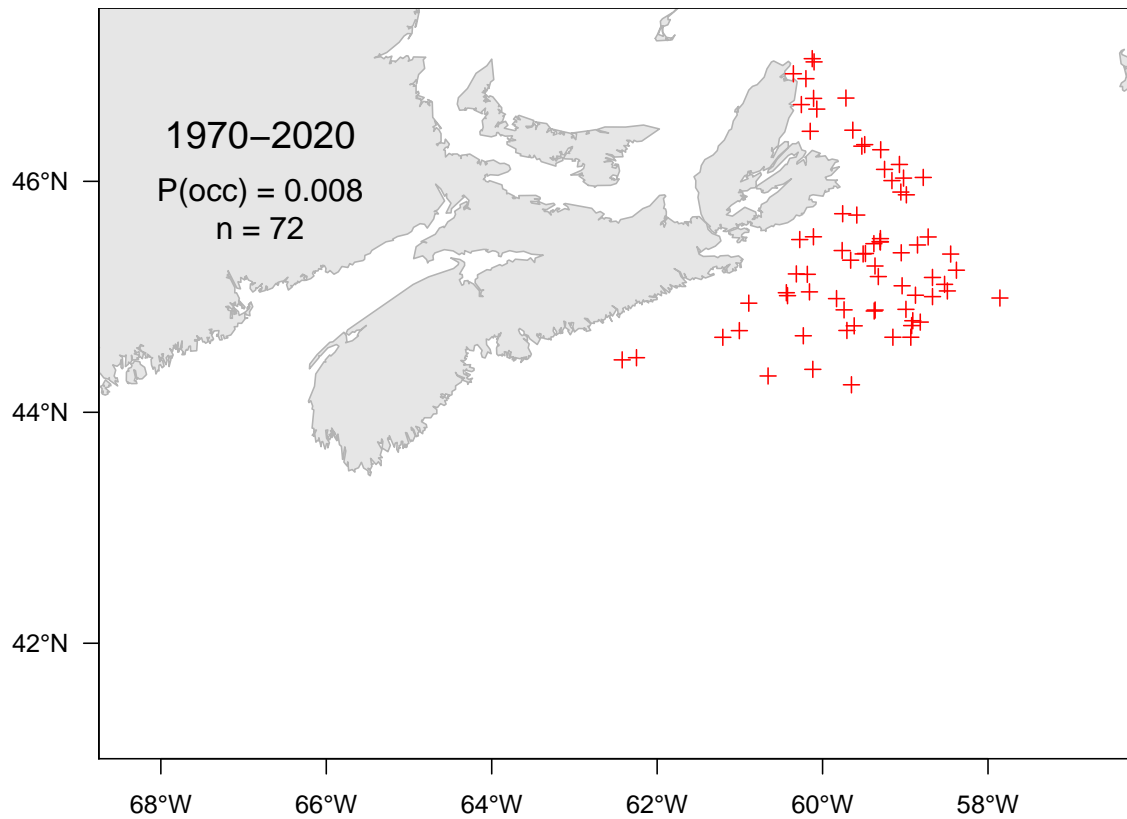
Figure 7.38A. Catch distribution for Newfoundland eelpout.

7.39 Rock gunnel (Sigouine de roche) - species code 621 (category LR)

Scientific name: Pholis gunnellus
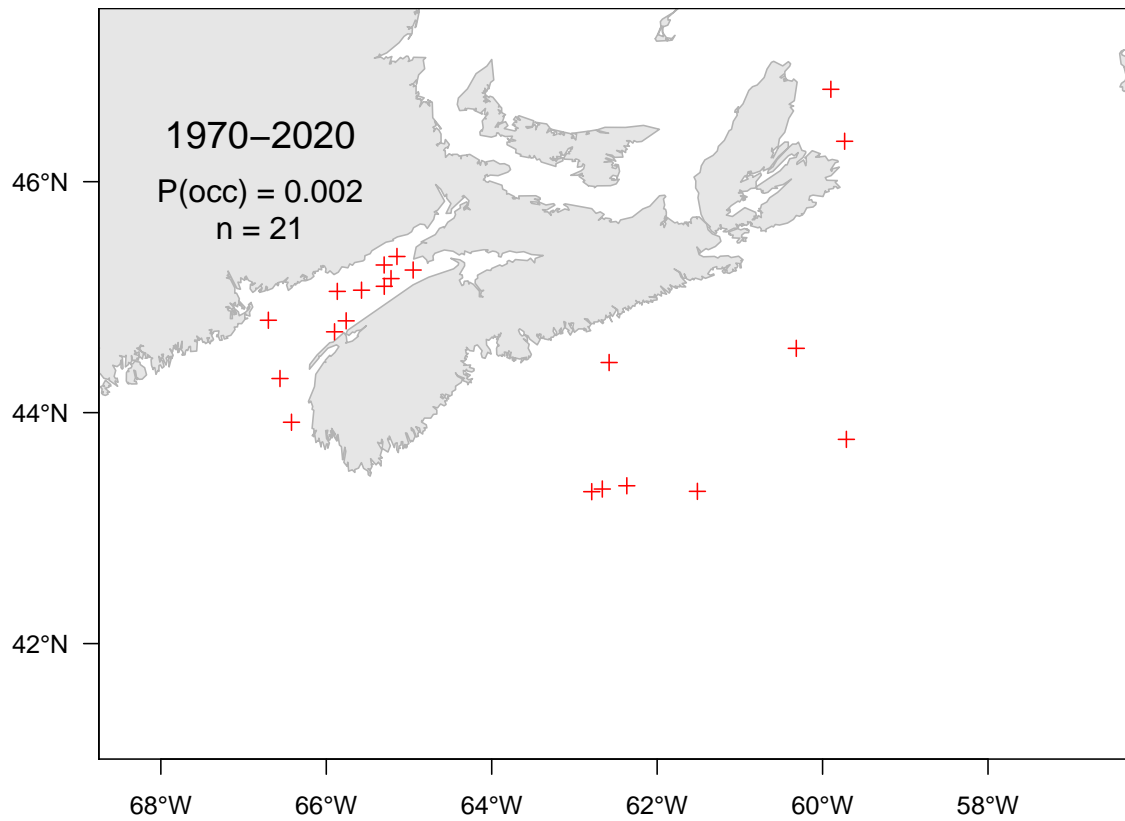
Figure 7.39A. Catch distribution for Rock gunnel.

7.40   Radiated shanny (Ulvaire deux-lignes) - species code 625 (category LR)

Scientific name: Ulvaria subbifurcata
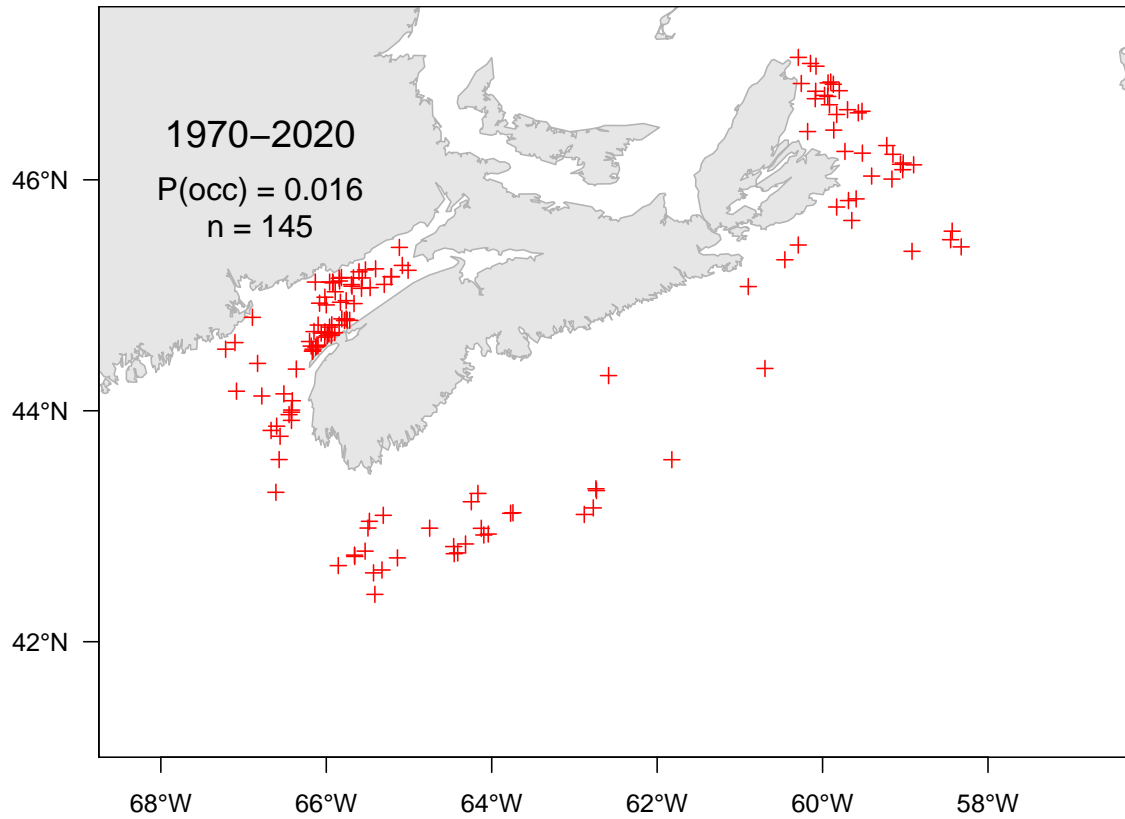
Figure 7.40A. Catch distribution for Radiated shanny.

7.41 Fourline snakeblenny (Quatre-lignes atlantique) - species code 626 (category LR)

Scientific name: *Eumesogrammus praecisus*
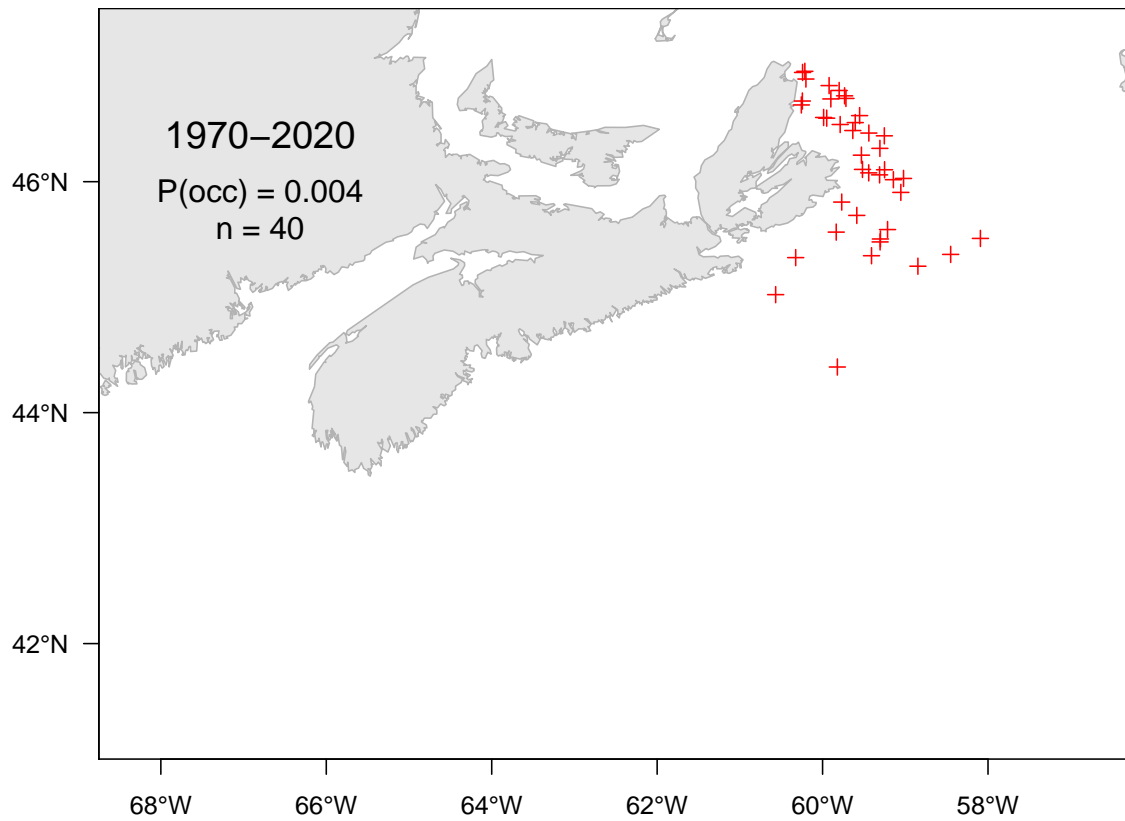
Figure 7.41A. Catch distribution for Fourline snakeblenny.

7.42 Wrymouth (Terrassier tacheté) - species code 630 (category LR)

Scientific name: Cryptacanthodes maculatus
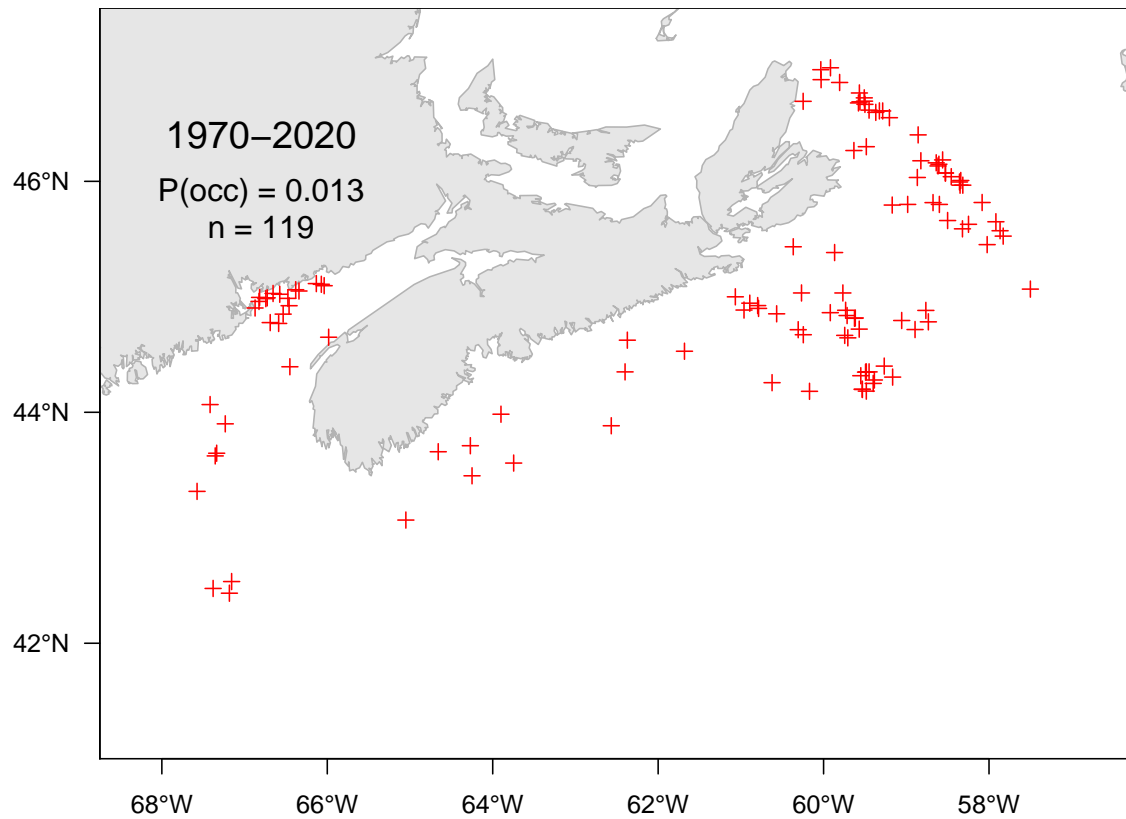
Figure 7.42A. Catch distribution for Wrymouth.

7.43 Spotfin dragonet (Dragonnet tacheté) - species code 637 (category LR)

Scientific name: Foetorepus agassizii
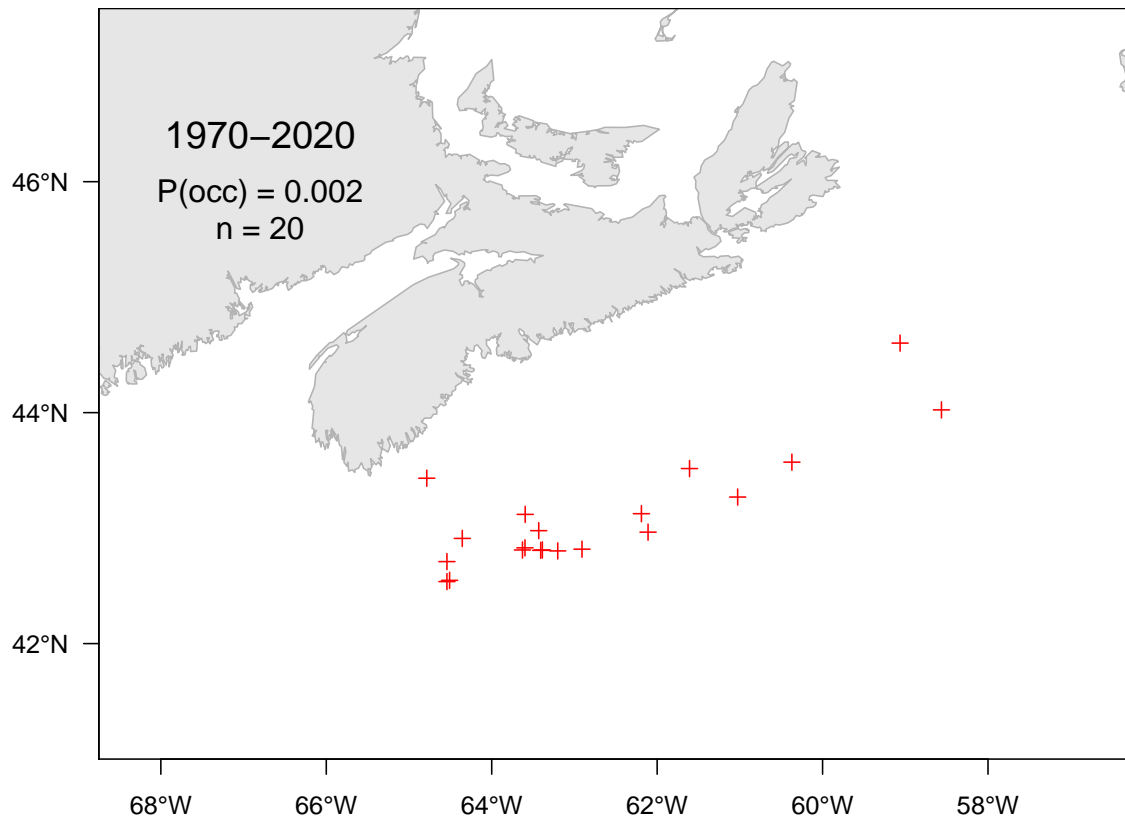
Figure 7.43A. Catch distribution for Spotfin dragonet.

7.44 Arctic eelpout (Lycode arctique) - species code 641 (category LR)

Scientific name: Lycodes reticulatus

1970–2020

P(occ) = 0.008

n = 70
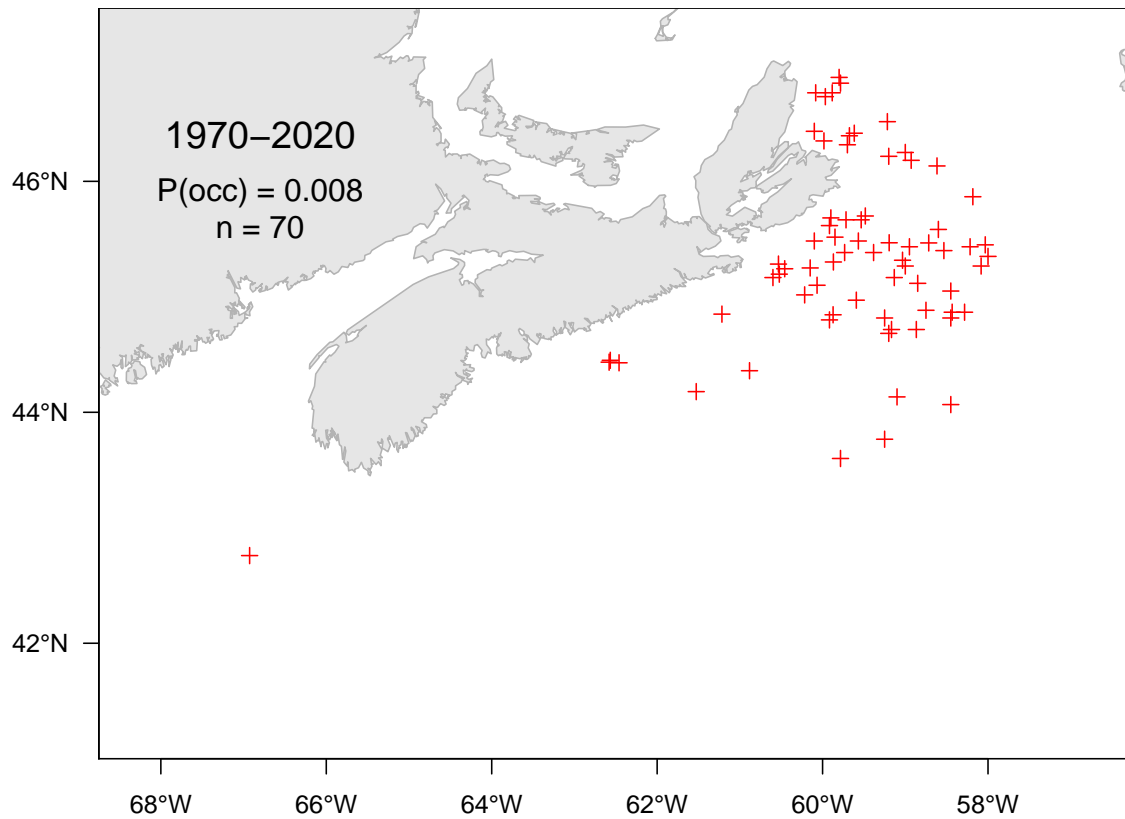
Figure 7.44A. Catch distribution for Arctic eelpout.

7.45 Atlantic soft pout (Molasse atlantique) - species code 646 (category LR)

Scientific name: Melanostigma atlanticum
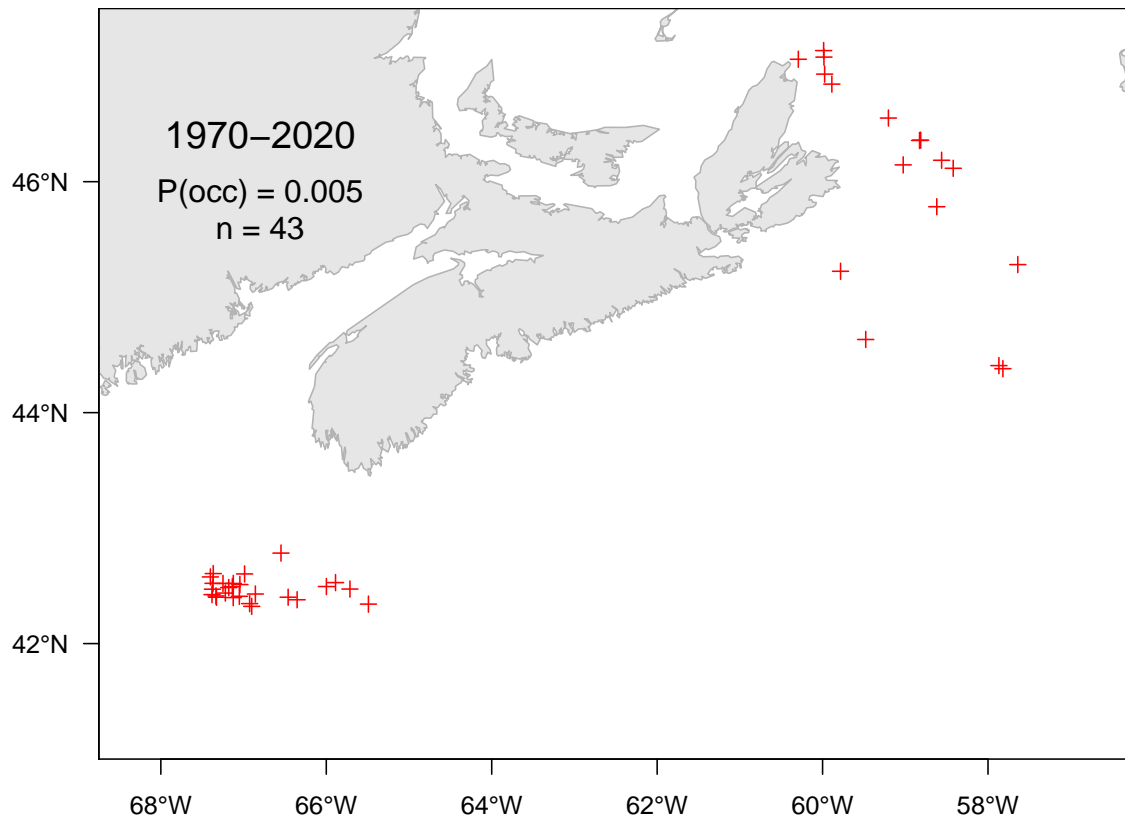
Figure 7.45A. Catch distribution for Atlantic soft pout.

7.46   Silvery John dory (Saint Pierre argenté) - species code 704 (category LR)

Scientific name: Zenopsis conchifer
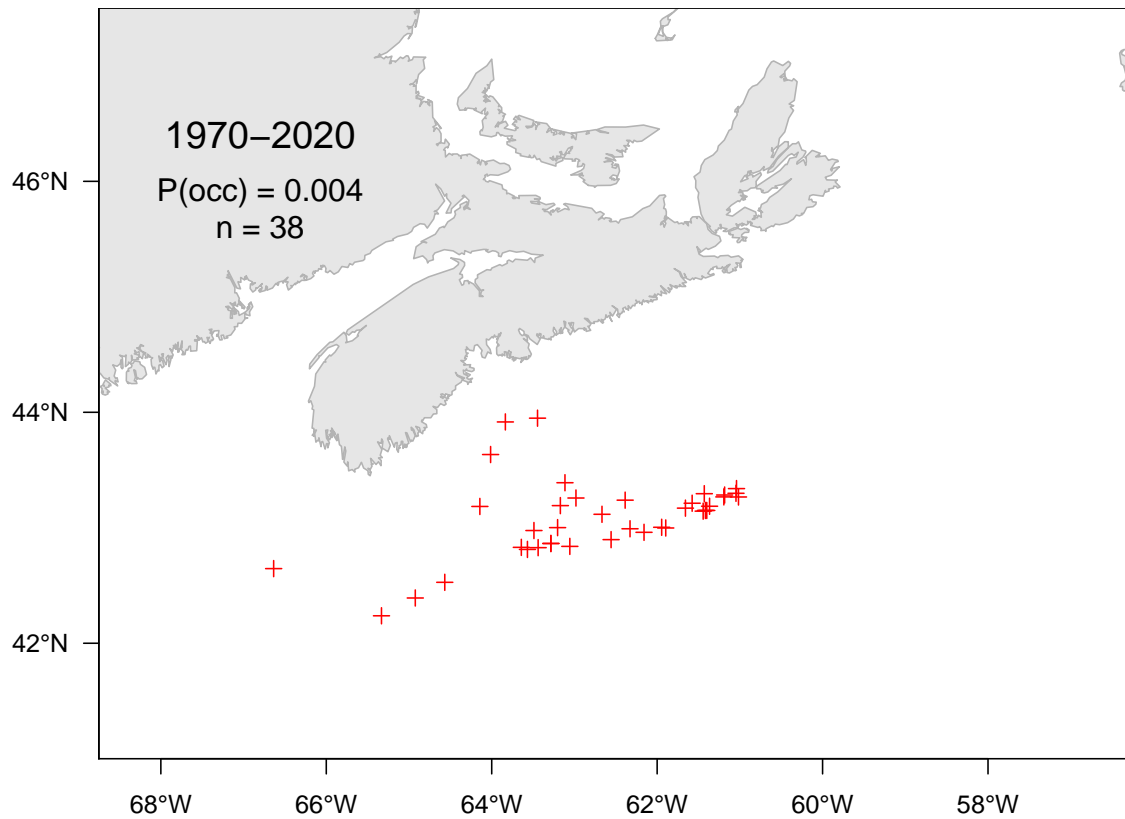
Figure 7.46A. Catch distribution for Silvery John dory.

7.47 White barracudina (Lussion blanc) - species code 712 (category LR)

Scientific name: Arctozenus risso
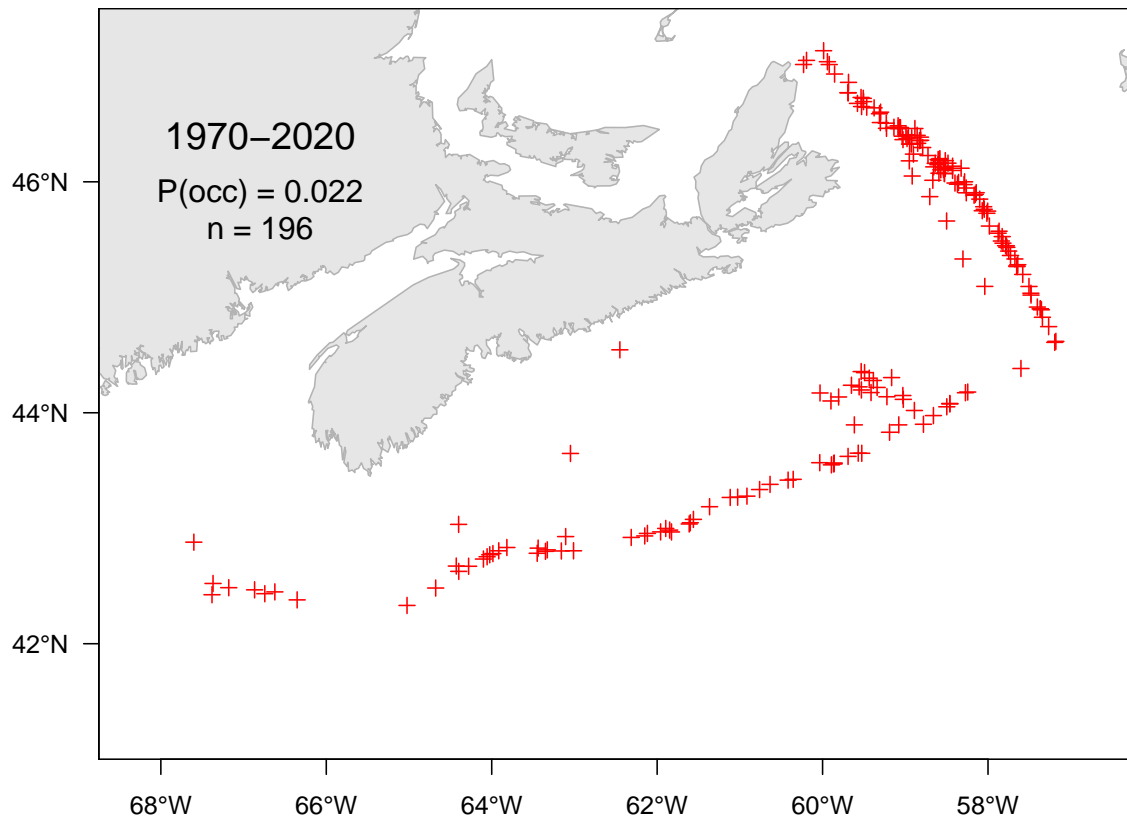
Figure 7.47A. Catch distribution for White barracudina.

7.48 Atlantic saury (Balaou atlantique) - species code 720 (category LR)

Scientific name: Scomberesox saurus
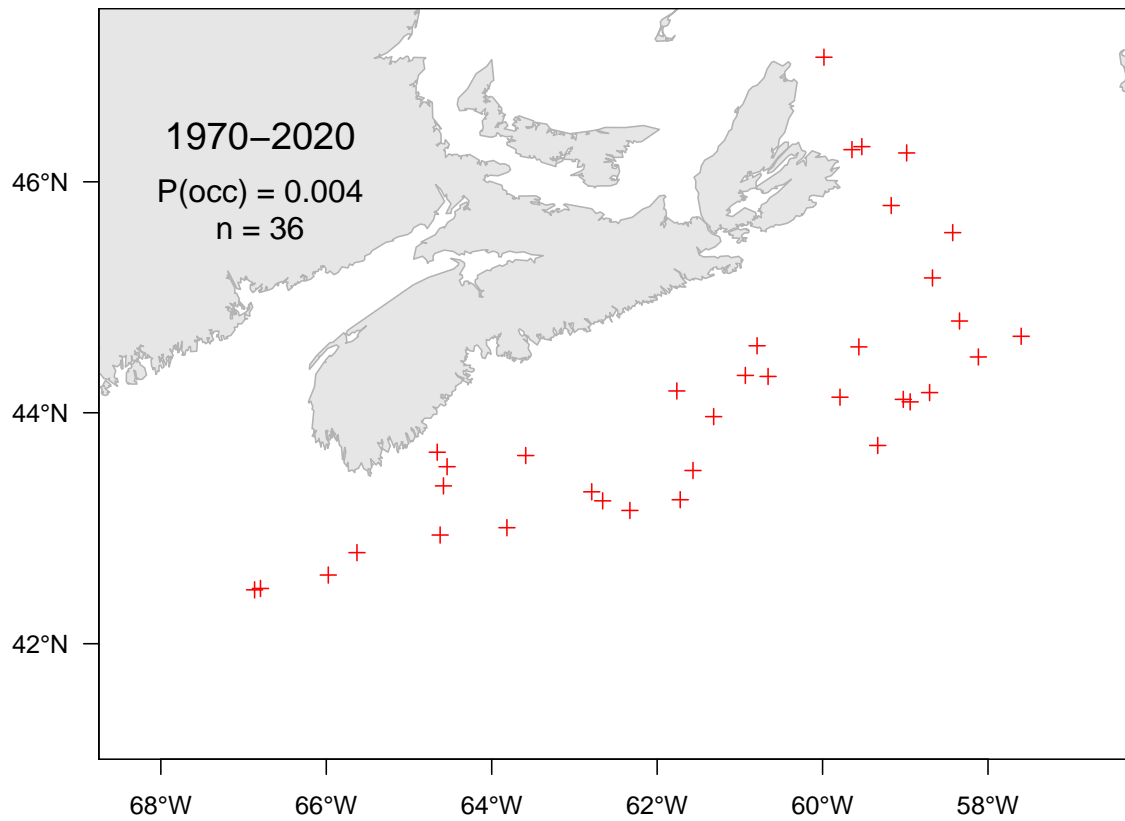
Figure 7.48A. Catch distribution for Atlantic saury.

7.49 Hatchetfishes (Haches d'argent) - species code 741 (category LR)

Scientific name: Sternoptychidae
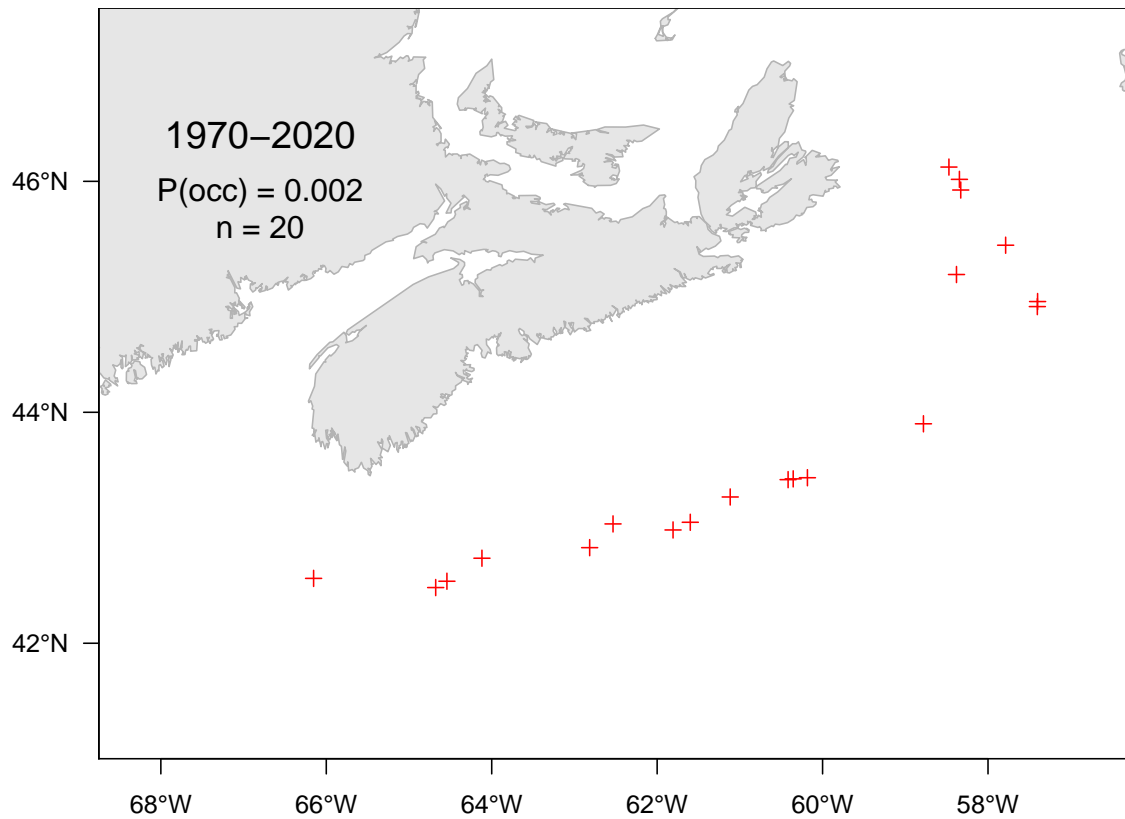
Figure 7.49A. Catch distribution for Hatchetfishes.

7.50   Atlantic batfish (Malthe atlantique) - species code 742 (category LR)

Scientific name: Dibranchus atlanticus

1970–2020
P(occ) = 0.002
n = 18
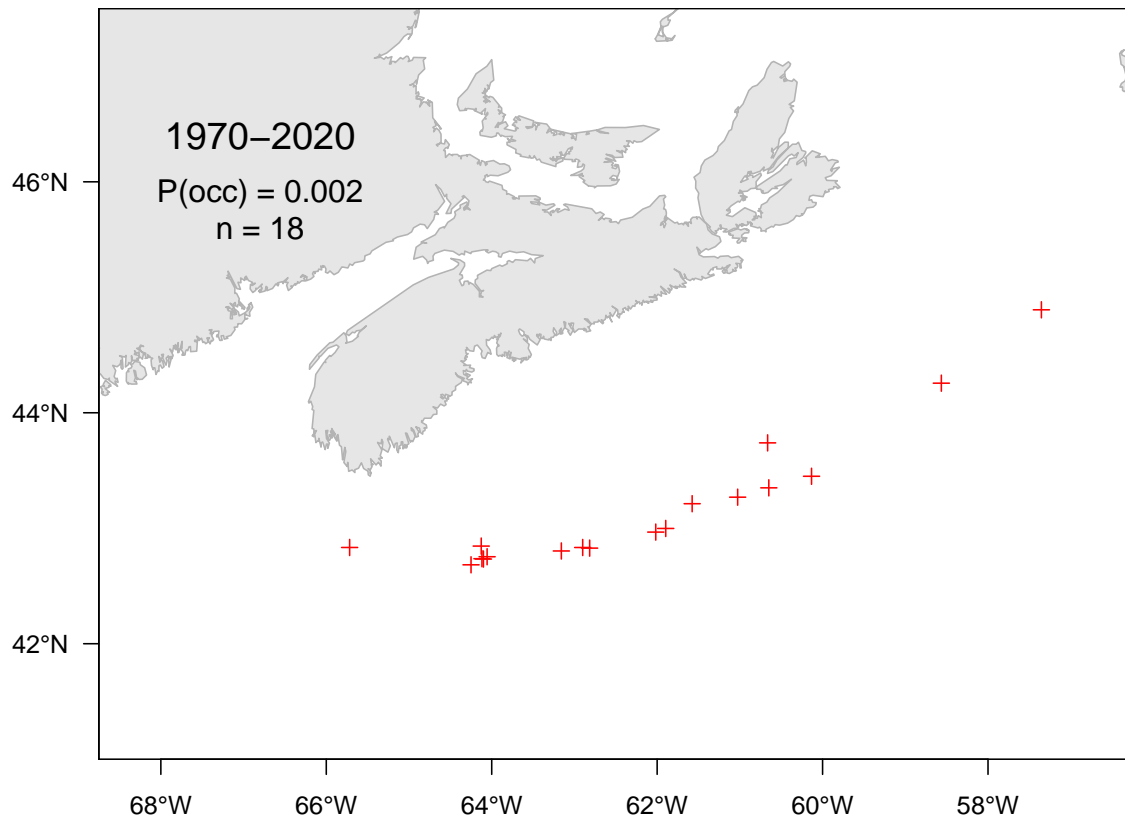
Figure 7.50A. Catch distribution for Atlantic batfish.

7.51   Spottedfin tonguefish (Langue fil noir) - species code 816 (category LR)

Scientific name: Symphurus diomedeanus
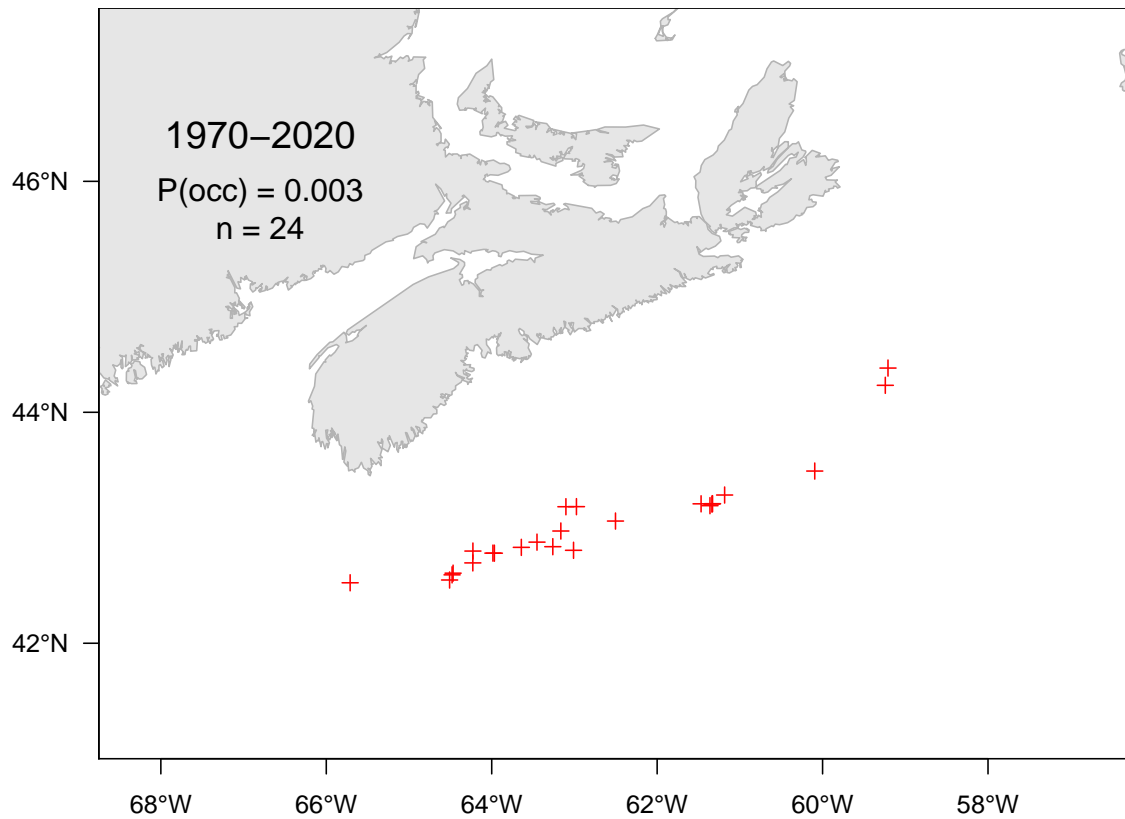
Figure 7.51A. Catch distribution for Spottedfin tonguefish.

7.52 Black dogfish (Aiguillat noir) - species code 221 (category LR)

Scientific name: Centroscyllium fabricii
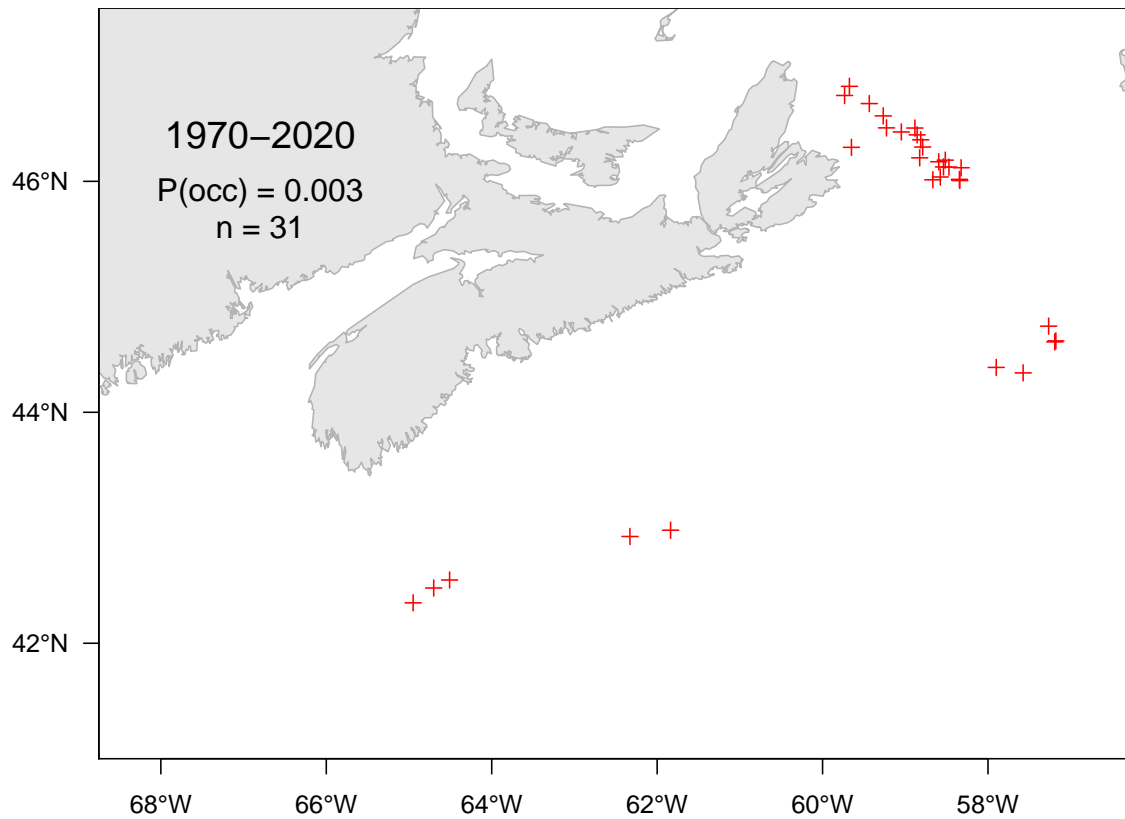
Figure 7.52A. Catch distribution for Black dogfish.

7.53   Longfin inshore squid (Calmar totam) - species code 4512 (category LR)

Scientific name: Doryteuthis pealeii
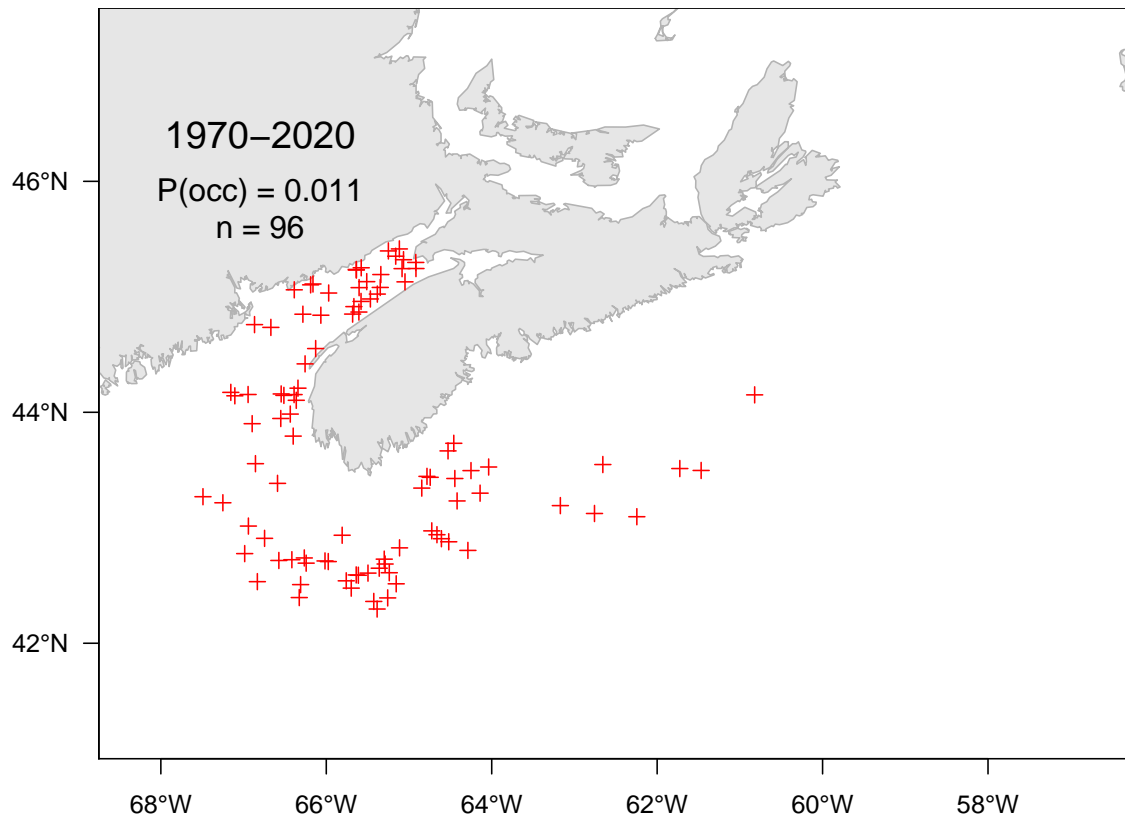
Figure 7.53A. Catch distribution for Longfin inshore squid.

7.54 Red deepsea crab (Crabe rouge) - species code 2532 (category SR)

Scientific name: Chaceon quinquedens
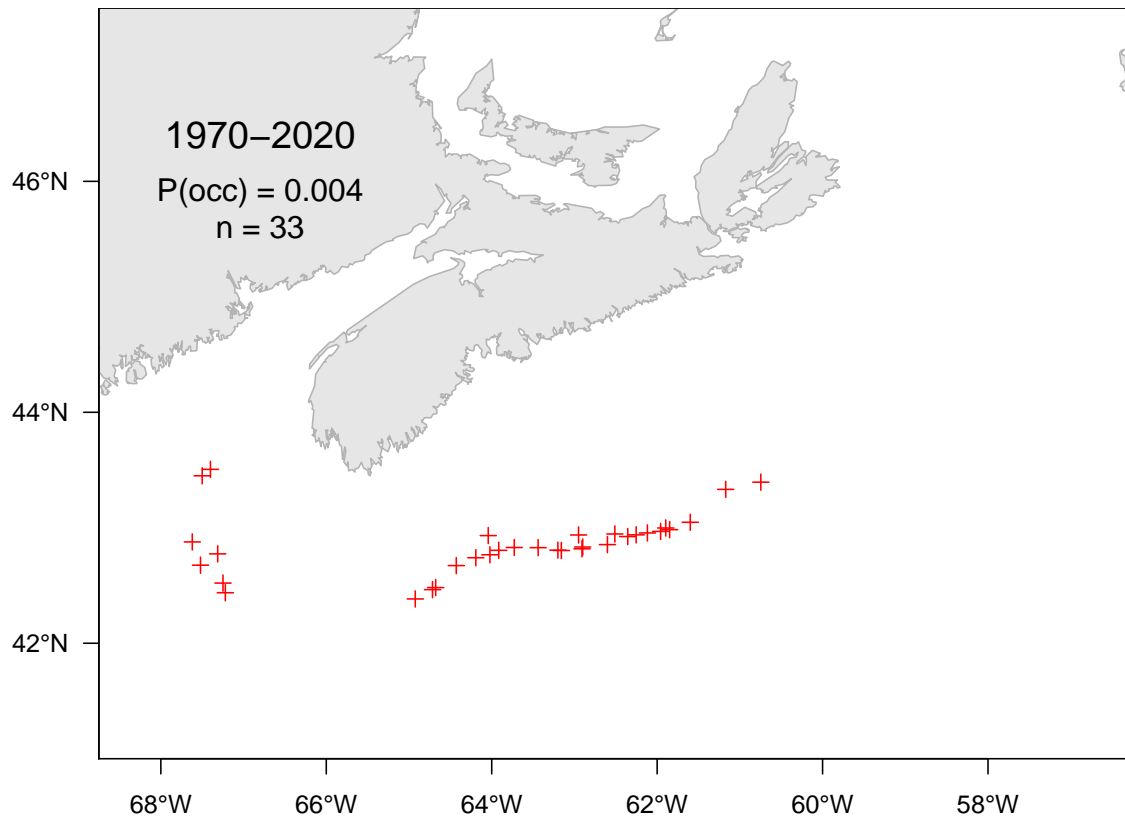
Figure 7.54A. Catch distribution for Red deepsea crab.

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